

HYSTERIACEAE: LIFE-HISTORIES OF CERTAIN SPECIES

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THE writer has undertaken to determine by pure-culture methods the status of stages in the life-histories of species of the Hysteriaceae, a family of doubtful affinities, composed largely of species seldom reported and poorly understood. Collecting was begun in the summer and fall of 1928.

HISTORICAL

Species studied in culture

If one regards the genus *Hysterium* as typical for these fungi, as Von Höhnelt (19) did, then the only culture studies that are known with any certainty for these forms are those of Brefeld (3, p. 271) with "*Glonium lineare* (Fr.), *Hysterium pulicare* (Pers.), *Hysterographium bifforme* (Fr.), . . . *Lophium mytilinum* (Pers.), *Hysterographium Fraxini* (Pers.)" Concerning these species Brefeld states that all except the last yielded in culture a luxuriant, widespread, brown or gray mycelium, and that none produced any sign of fructification during the nine or ten months of observed growth. *H. Fraxini* produced a very scant growth of white mycelium. According to Brefeld (2), Möller studied *H. pulicare* in culture and obtained similar mycelia from germinating "spermatia" and ascospores.

Taxonomy

The order Hysteriales, as commonly delimited, is equivalent to the Hysteriineae of Lindau (27), who retained the terminology of Schroeter (42, pp. 62, 142), described the group, and subdivided it into five families, with a total of twenty-nine genera. At a later date he (28) added five more genera. This classification

* Papers from the Department of Botany of the University of Michigan, No. 367.

is fundamentally the same as that proposed by Rehm (36). In contrast to these systems we have Saccardo's Hysteriaceae (*Syll. Fung.*, 2: 721. 1883) with twenty-eight genera at first, a number later increased to fifty-three through additions in subsequent volumes of the *Sylloge Fungorum*.

Bisby (1) has well reviewed the early literature on the taxonomy of the group and has also summarized Von Höhnel's disposition of the genera of Saccardo's Hysteriaceae.¹ The studies of Hilitzer (18), Lagerberg (24), Lind (26), Minks (32) and Rehm (38), and the ideas expressed by Fink (14-16) on the classification of these fungi might be added — largely for their historical interest — to supplement the review by Bisby. Hilitzer's recent monograph presents named and described pycnidial stages for a number of the species of the Hypodermataceae and for six species of the Hysteriaceae. The author proposed the form genus *Hysteropycnis* to receive the latter. The paper of Lagerberg contains in part a discussion on the limitation of genera in the Hypodermataceae.

As early as 1881 Minks set about to establish a line of demarcation between lichens and hysteriaceous fungi, placing greatest emphasis on hymenial structure. Although he made no definite disposition of species, suggesting that this might be done by the various systematists on the basis of his notes, it is apparent that he favored the transfer of many carbonaceous, hysteriaceous forms to the category of lichens. Rehm, again revising the Hysteriineae in 1912, transferred his genus *Hysteropatella* from the Patellariaceae to this family. Fink, in distributing lichen genera among the Fungi, placed the Graphidaceae and the Arthoniaceae in the Hysteriales.

The Hysteriaceae as limited by Von Höhnel (19) include 327 described species. Approximately 100 have been reported for North America, and of that number 81 have been described,

¹ In a later paper, "Type Specimens of Certain Hysteriales," Professor G. R. Bisby has summarized his notes on certain types in European herbaria. His paper is a recent, significant advance in the status of the nomenclature in these fungi. I am thankful to him for the privilege of examining a copy of his manuscript while his paper was in press. It has since been published in *Mycologia*, 24: 304-329. 1932.

largely by early workers, from American material. It is estimated that about 60 per cent of the species described from American material have not been reported since the original discovery, or that collections have been questionably referred to such species. This situation results from our ignorance of diagnostic characters and specific limitations in these fungi, and suggests that any satisfactory revision of this family must await comparative culture studies.

Associated conidial stages

In 1897 Lindau (27, p. 266) summarized the status of imperfect stage connections in the Hysteriales somewhat as follows: "So far as known the members of the Hysteriales do not produce imperfect stages in culture, but only sterile mycelia. Pycnidia have been observed as associated with many species. These are in part Leptostromaceae (Hypodermataceae) and in part Exciplacaceae (species of *Dichaena*). The conidia are always elongate, unicellular, and hyaline." It is to be noted that none of the species of his *Hysteriaceae* are included. As a matter of fact, associated imperfect stages had been described in the literature previous to 1897, for several species of *Hysterium*, for *Hystero-graphium Frazini*, and for two species of *Lophium*. However, only the conidial stages of the two species of *Lophium* were referred to definite form genera at that time.

A review of the literature on hysteriaceous species indicates that even brief descriptions of associated imperfect stages exist for only a few species. Some of these associations are very questionable and none have been demonstrated by cultural methods.

Dichaena. — The exact status of the species that have been referred to the genus *Dichaena* (Fries, *Sys. Orb. Veg.* 1: 108. 1825) is not clear. It is commonly stated that the conidial stage of these species appears as a stylosporoc fructification within the hysterothecium and that the ascigerous stage is seldom produced. Descriptions of imperfect stages (*Psilospora* and *Dichaenopsis*) that have been referred to the several species are also conflicting.

Glioniopsis. — Hilitzer (18) described *Hysteropycnis admixta* Hilitzer as a pycnidial stage in association with a form which has been known as *Glioniopsis bififormis* (Fr.) Sacc. He contended

that the perfect stage is not referable to *Hysterium biforme* Fr. and, not giving Gloniopsis generic ranking, proposed the name *Hysterographium Dubyi* Hilitzer. The pycnidia of this fungus are globular, 0.1–0.3 mm. in diameter, and the pycnidiospores are hyaline, elliptic, and measure $3-5 \times 1-1.5 \mu$.

Glonium. — *Hysteropycnis globularis* Hilitzer (*op. cit.*, p. 151) is described as a pycnidial stage associated with *G. lineare* (Fr.) De Not. (*Psiloglonium lineare* Petrak). The pycnidiospores are elliptic or elliptic-oblong and measure $4-5 \times 1.5-2 \mu$.

Hysterium. — Brefeld (2, p. 47) mentioned that Möller had germinated the conidia from fructifications associated with *H. pulicare* (Pers.) Fr. No description is given. In the description of *H. Prostii* Duby, Saccardo (*Syll. Fung.*, 2:746) described the conidia as elongate and stalked. Duby (9, p. 38) did not mention the conidia when he described the species. Saccardo (*op. cit.*, 2:716) described the conidia of *H. melaleucae* F. Tassi as hyaline and stalked, measuring $2-2.5 \times 0.3-0.5 \mu$. Hilitzer (18, p. 151) described a pycnidial stage for *H. alneum* Schröt. (*H. pulicare*) and named it *Hysteropycnis occulta*. The pycnidia measure 0.05–0.1 mm. in diameter, and the pycnidiospores are simple, elliptic, hyaline, and measure $2-3 \times 0.5-1 \mu$.

Hysterographium. — Rostrup (40) described a pathologic condition of young ash and concluded, without inoculation or other cultural studies, that *H. Fraxini* (Pers. ex Fr.) De Not. was the causal organism. On the diseased ash a pycnidial stage with hyaline, cylindrical, stylosporic conidia measuring $32-38 \times 11 \mu$ appeared in the summer and later, on the same areas but particularly on the fallen twigs, the hysterothecia of *H. Fraxini* were produced. He associated the pycnidial stage with the long-known perfect stage. Rostrup indicated in a later publication (41, p. 120) that he had observed this organism as a parasite of the ash in several other localities. Lind (26) referred the pycnidial stage to the form genus *Myxosporium*.

Hilitzer (18, p. 152) described a pycnidial stage for *H. Fraxini* as *Hysteropycnis Fraxini*. The pycnidiospores are cylindric, hyaline, and measure $3-6 \times 1-1.5 \mu$. He also described *Hysteropycnis confluens*, with pycnidia measuring 0.1–0.5 mm. in diameter,

and with hyaline, oblong-elliptic pycnidiospores measuring $3\text{--}4.5 \times 0.5\text{--}0.8 \mu$, as an imperfect stage associated with *Hysterographium elongatum* Corda.

Lophium. — The Tulasnes (*Sel. Fung. Carp.*, 2 : 259) considered *Phragmotrichum Chailletii* Kunze & Schmidt (Kunze, *Myk. Hefte*, 2 [1823] : 84, t. 2, f. 4; Engler and Prantl, *Natür. Pflanzenf.*, 1, Abt. I [1899] : 414, f. 216, D) to be a conidial stage of *L. mytilinum* (Pers.) Fr.

According to Rehm (36, p. 1211), *L. Eriophori* Hennings is accompanied by *Leptostroma Henningsii* Allescher. The elongate, hyaline, unicellular conidia measure $5\text{--}8 \times 1 \mu$. In 1912 Rehm remarked (38, p. 112) that *L. Eriophori* might be nothing more than a form of *L. mytilinum*. This is the only association in which a *Leptostroma* connection has been suggested for a hysteriaceous fungus.

Mytilidion. — Duby (9, p. 27) described the spermatia as "free" for *M. aggregatum* (DC.) Duby. In the generic description (*op. cit.*, p. 34) he stated that the spermatia were minute, elliptic-elongate, hyaline, and produced in mucilaginous layers in the membranous spermatogonia. Rehm (35), in his revision of the *Hysteriineae* in the herbarium of Duby, noted for one of the specimens (*Lophium aggregatum* Fr.) under the name given above that the spermatia were hyaline, mostly curved, and measured $5 \times 1 \mu$. In connection with *M. aggregatum* Duby, Hilitzer (18) mentioned globular, ostiolate pycnidia 0.1 to 0.2 mm. in diameter, with pycnidiospores 2 to 2.5μ in diameter.

The writer's announcement (30) that he had obtained a pycnidial stage of the *Sphaeronaema* type in pure cultures of *Glonium parvulum* (Ger.) [Sacc.] Cke. is apparently the first one that establishes definitely an imperfect stage connection in the hysteriaceous fungi.

METHODS AND MATERIALS

Isolations

The stock cultures used in this study originated in the isolation of single germinating ascospores and individual asci with retained germinating spores, from sprays on Kauffman's synthetic agar

medium. The recipe for preparing this medium, the method of isolation, and the succession of physical factors to which stock cultures were subject have been published by the writer (30, pp. 144, 146). The colored and comparatively large spores in most of the species, and the fact that conidial stages upon or within the hysterothecium are not common, made single-spore isolation a relatively easy task.

Ascospore germination

The physiological state of maturity of a spore determines the exact stimuli which will affect its germination, and when both are known, spores can be germinated at will. But in these slowly growing fungi the maturity of a given spore sample from collected material is not definitely determinable. To ascertain the effects of the season on maturity, groups of undisturbed hysterothecia of *Glonium parvulum*, *Hysterographium Mori*, and *Gloniopsis Gerardiana*, on their natural substrata, were subjected to natural weathering through two winters and the intervening warmer months, and were examined at intervals. Throughout the period of observation no noticeable changes occurred in the apparent maturity of hysterothecia, and microscopic examinations always revealed hymenial elements of varying development. Several of the species have been collected in "good condition" during all seasons of the year. It is evident that the hysterothecia are perennial and that the plants continue to produce and mature their spores for at least a few years within a single fruit body. In the examination of material it is not uncommon to find spores that have germinated within the ascus. Yet in some species, *Hysterographium vulvatum* and *H. Fraxini* in particular, ascospore germination proved to be a real problem.

The stimulus employed to induce spore germination in certain collections was a periodic wetting and drying at room temperature at intervals of from twelve to forty-eight hours for several days. Such treatment failed to stimulate germination in *H. Fraxini*. After being subjected to freezing temperatures (-30 , -25 , or -4° C.), with intervals of thawing at 25° C., spores at various stages of morphological maturity germinated readily.

Since the Hysteriaceae present spores of widely diverse morphological types, and since the present genera are delimited largely by spore characteristics, the comparative morphology of the germ-tube hyphae was studied in particular. The results and the conditions under which germination was observed are presented elsewhere (31).

The germination of secondary spores

Hyphomycetous and sphaeropsidaceous imperfect stages have been encountered in the study of these fungi. The terminology would be more in accord with that of past literature if the latter types were referred to as spermatogonia, since the fructifications are very minute and their spores are extremely small, hyaline, and unicellular. However, these so-called spermatia have been germinated in nearly half of the species studied, and it is appropriate that the fructifications be referred to as pycnidia, and their reproductive cells as pycnidiospores. Moreover, in *Lophium mytilinum*, *Glonium parvulum*, and *Hysterium insidens* single-pycnidiospore isolations have yielded mycelia vegetatively indistinguishable from the single-ascospore cultures of the same species. A culture derived from a single, culturally produced pycnidiospore is illustrated (Fig. 31A).

The method of alternate wetting and drying stimulated pycnidiospore germination. It usually had to be employed in the germination of culturally produced pycnidiospores. After a prolonged treatment of the pycnidiospores from field material the writer succeeded in germinating them in *Lophium mytilinum*, but failed in *Glonium stellatum*. In the attempt to isolate the latter species, and in the isolation of *Lophium mytilinum* and *Hysterium insidens* from secondary spores obtained from field material, the procedure outlined for the isolation of ascospores was followed, except that it was necessary to omit the initial washing in 95 per cent alcohol. The germination of secondary spores was observed in distilled water and, for species isolated from such spores, on nutrient agar plates. Tests for germination were made at 20 to 25° C.

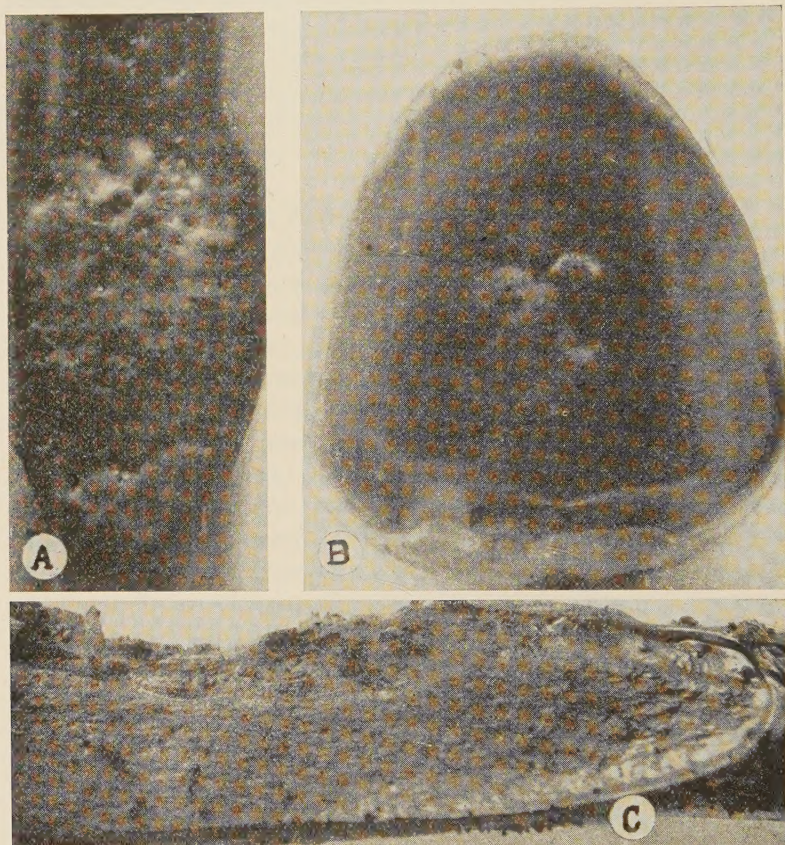


FIG. 31. A, *Glonium parvulum*. Mature pycnidia (*Sphaeronaema parvulum*) twice the actual size, with their apical globular masses of exuded spores; single-pycnidiospore culture on the Leonian medium after eleven months at 20 to 25° C. B, *Hysterium insidens*. Massed conidial (*Septonema spilomeum*) filaments, actual size; single-ascus culture on the Leonian medium after four months at 20 to 25° C. C, *Lophium mytilinum*. Erumpent, composite, pycnidial fructifications twice the actual size; single-ascospore culture on pine bark seated in a pine-bark decoction agar medium; seven months at 20 to 25° C.

Culture media

Stock cultures were maintained on a sucrose-oatmeal medium containing 60 gr. of ground oatmeal, 40 gr. of cane sugar, and 15 gr. of agar to one liter of distilled water. Leonian's agar (25, p. 21), peptone omitted, was adopted as a medium favorable to the production of imperfect stages. Comparative culture notes on vegetative habits were recorded for cultures on these two media, although the former can scarcely be considered a standardized medium. Special substrata, such as sterilized *Quercus* and *Prunus* blocks, *Rhus* and *Fraxinus* twigs, *Pinus* bark and mixed-wood sawdust, were utilized in the culture of certain species. These are indicated in the discussion of the particular species. Species from coniferous hosts were cultured on a 2 per cent agar medium of pine-bark decoction.

Fungi in culture

The following species were grown in culture: *Lophium mytilinum* (Pers.) Fr., *L. dolabriforme* Wallr., *Glonium stellatum* Muhl. ex Fr., *G. simulans* Ger., *G. parvulum* (Ger.) Cooke, *G. lineare* (Fr.) De Not., *Mytilidion tortile* (Schw.) Sacc., *M. laeviusculum* (Karst.) Sacc., *M. decipiens* (Karst.) Sacc., *M. resinicola*, sp. nov., *M. Thujarum* (C. & P.), comb. nov., *Hysterium pulicare* Pers. ex Fr., *H. angustatum* Alb. & Schw., *H. insidens* Schw., *Hystero-graphium kansense* E. & E., *H. minutum*, sp. nov., *H. Mori* (Schw.) Rehm, *H. Lesquereuxii* (Duby) Sacc., *H. formosum* (Cooke) Sacc., *H. vulvatum* (Schw.) Rehm, *H. Fraxini* (Pers. ex Fr.) De Not., *Gloniopsis brevisaccata*, sp. nov., *G. Gerardiana* Sacc., *Hystero-patella Prostii* (Duby) Rehm, and *H. clavispora* (Peck) Seaver.

LIFE-HISTORIES ²*Lophium mytilinum* (Pers.) Fr.

No. 191. Fruiting abundantly on bark and exposed wood of dead branches of *Pinus sylvestris* L., Ann Arbor, Mich., Nov. 5,

² The collections upon which the studies are based are deposited in the University of Michigan Herbarium. Their numbers, as indicated herein, represent both the writer's culture number and the accession number in his herbarium. In the notes treating general cultural characteristics reference

1929. Collected by G. B. Cummins and M. L. Lohman. No. 280. On twigs of *Pinus Strobus* L., Ann Arbor, Mich., Sept. 19, 1930. Collected by M. L. Lohman.

Mature hysterothecia, $0.4-0.7 \times 0.1-0.5$ mm., the height equaling or exceeding the width; asci $150-190 \times 7-8 \mu$; spores (120) $140-175 \times 2 \mu$, yellowish hyaline, filiform, and 18-20-septate.

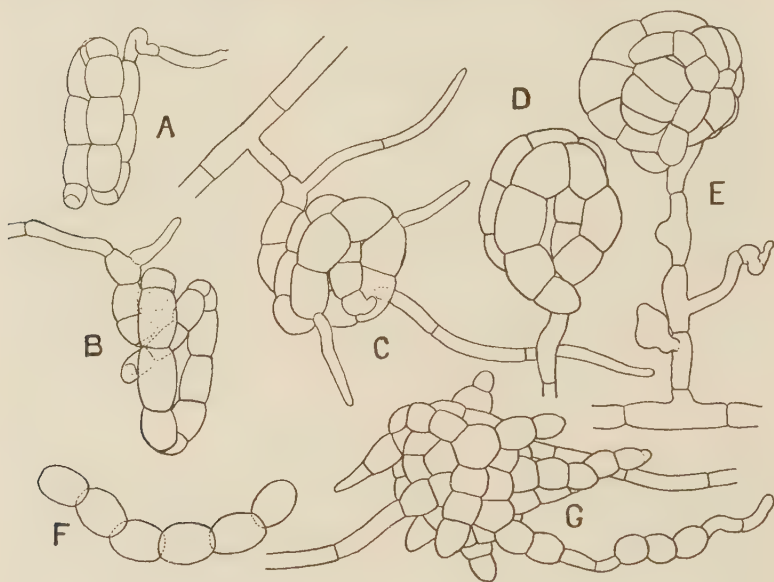


FIG. 32. A-E, *Lophium mytilinum*; *Papulospora mytilina* stage. A-B, early stages in conidial development; C, a germinating conidium; all from cultures. D-E, conidia from field material. F-G, *Lophium dolabrilforme*. F, portion of catenulate filament from superficial layer in cultures; G, sclerotial body from surface layer in cultures

L. mytilinum has also been collected near Ann Arbor, on cones of *P. ponderosa* Dougl. and on old stumps of *Larix laricina* (Du Roi) Koch.

Vegetative cultural characteristics. — Growing mycelia are dark ("dark grayish olive" to "olivaceous black 2"), with a lighter

is to cultures on the Leonian and oatmeal media in the light at 20 to 25° C., unless other conditions are recorded. Quoted color terms are those of Ridgway (39).

greenish tinge at the margin. The aërial hyphae are lighter in color and soon become "light pinkish cinnamon" to "wood brown." The species produces a pink coloration of the oatmeal medium, especially in cultures held at the lower temperatures. A hyphomycetous stage (Figs. 32 A-E) and a pycnidial stage (Fig. 33) have been obtained on single-ascospore, single-ascus,

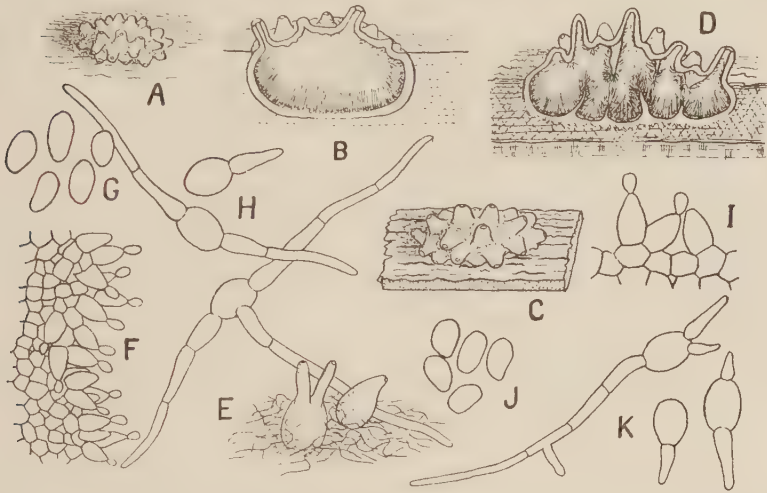


FIG. 33. *Lophium mytilinum*; pycnidial stage. A, a pycnidial fructification on agar medium, $\times 30$; B, the same in sectional view; C, a pycnidial fructification in outer bark of *Pinus strobus* twig, $\times 60$; D, the same in sectional view; E, pycnidia from the superficial layer in cultures on mixed-wood sawdust; F-G, spore-bearing cells and spores from C; H, germinating pycnidiospores from field material; I-J, spore-bearing cells and spores from A; K, germinating pycnidiospores from fructifications obtained in culture

single-conidium, and single-pycnidiospore cultures grown on various media.

Cultural fructifications. — Anastomosing aërial hyphae initiate "bulbil" primordia, each of which may develop one or several subglobose, dark fuscous, propagative bodies (herein referred to as conidia) of the Papulospora type (Figs. 32 A-B). The conidia develop as coiling-hyphal tips which form spirals of several turns each. The coiling hyphae are closely septate, and the distal

ends of many grow tortuously through the coils to form compact conidia measuring $15-18 \times 10-12 \mu$, the smaller dimension being in the direction of the axis. The coiling hypha is 3 to 5 μ in diameter and seldom branches in the formation of a single conidium. Additional conidia arise either by the prolongation of the conidiophore or by the development of a secondary conidiophore from the first or second cell of the coil. These processes in some specimens are continued until six or eight conidia are formed in close proximity. Occasionally compound bulbils result wherein single conidia are not discernible. The spiral condition is not always evident in a mature conidium. On the oatmeal medium at 10° C. these conidia were not produced, but, instead, torulose hyphae developed numerous, clustered, septate, uncoiled, tortuous, finger-like projections, undoubtedly potential conidial filaments, because mature conidia were obtained on this medium at higher temperatures. Typical conidia were obtained on the Leonian medium at 10° C.

The conidia obtained in culture were isolated, their germination was studied, and single-conidium cultures returned the conidial stage and produced a pycnidial stage as well.

Single-ascospore and single-ascus cultures on the Leonian medium produced a pycnidial stage on their marginal mycelia within five to eight weeks. The black, erumpent fructifications were carbonaceous, at first smooth above but later ten to twenty-four ostiolate-papillate (Figs. 33 A-B). Exuding pycnidiospores collected in gelatinous spherical masses at the tips of the minute papillate tubercles. In general, the compound pycnidia obtained on agar media measure $(250) 400-600 \times (200) 350-400 \mu$. They have complete, subcarbonaceous, parenchymatous walls 10 to 15 (20) μ in thickness, with the outer cell layers opaque, the inner hyaline, and bearing sporulating cells. The ostiolate papillae vary greatly in length. They measure 30 to 40 (60) μ in their median diameter. The sporulating cells are obovate, (2.5) $3-5 \times 2-2.5 \mu$, and they line the lateral and basal walls and abstrict the pycnidiospores singly from their tips. The pycnidiospores are hyaline, oblong-elliptic to inequilateral or subballantoid, and they measure $1.5-2 (2.5) \times 1-1.5 \mu$. They germinate, after con-

siderable swelling, by one or two terminal germ hyphae (Fig. 33 K). At maturity the compound fructification is provided with a single cavity and a number of papillae.

Cultures on sterilized deciduous-wood sawdust produced pycnidia in the aërial mycelium, a circumstance which Coons (5) attributed to unfavorable physico-chemical conditions. These pycnidia (Fig. 33 E) were smaller, measuring (75) $100-150 \times (95) 130-150 \mu$ exclusive of the beaks. The latter measured (120) $140-170 \mu$ in length, with an average median diameter of 25 to 30μ . A number of the smaller pycnidia possessed but one beak. In these cultures the young pycnidia are globose and at first develop outwardly in all directions by the close interweaving of minute, tortuous hyphae. Later a central cavity appears, development is upward, and the beaks appear as pycnidiospore formation is initiated. In the aërial mycelium the primordia arise symphogenously, a manner of pycnidial development considered by Kempton (23) to be uncommon.

Observed associations. — The first collections of *L. mytilinum* exhibited an associated hyphomycetous stage, which was questionably referred at the time to *Helicoma olivaceum* (Karst.) Linder (29, p. 302). When less symmetrical conidia appeared in cultures of *L. mytilinum*, numerous collections of the perfect stage were made to determine the constancy of the conidial form in the associated hyphomycetous stage, particularly since Linder, basing his opinions on culture studies, has emphasized the constancy of spore form in species of helicosporous fungi. Further studies disclosed the fact that the first collections were only early stages in the development of a *Papulospora* type of conidium similar to that obtained in culture.

The conidial stage is most abundant on the wood or inner bark beneath the loosened outer bark. On exposed surfaces the conidia are readily disseminated, and only a dark brown hyphal crust remains. It is not uncommon to find this crust crowning old pycnidial clusters on dead twigs. When in good condition the conidial clusters completely fill the cavities left by the disintegrated pycnidia. In the less exposed areas the conidia are produced in irregularly circular clusters 100 to 200μ in diameter.

They are closely compact, olivaceous to brown in mass, but become black on drying. In the first-coil stage they are five- to seven-celled and measure $13-15 \times 8-10 \mu$. At maturity they are compactly and rather indistinctly coiled, and are $16-18 (24) \times 13-15 \mu$. The yellowish conidiophores are two- to four-celled, 15 to 30μ in length, and 2.5μ in diameter, or, in proliferating clusters, they are scarcely discernible. Widely effused brown crusts formed by compact, upright, branching, torulose, non-sporiferous hyphae 45 to 50μ in length and 5μ in diameter are not uncommon. No stage has been observed comparable to *Phragmotrichum Chailletii* Kunze & Schmidt (see p. 233), which is recorded in the literature as an imperfect stage of *L. mytilinum*.

Conidial development in this hyphomycetous stage is the same as that described by Hotson (21, p. 283) for *Papulospora sporotrichoides* Hotson, and in his artificial classification the stage would occupy a similar position. However, in the stage described above, the mycelium is dark, the bulbils are smaller, and the accessory conidia are produced in pycnidia. The name *Papulospora mytilina* (Pers.) Lohman, status novus *Lophii mytilini* (*Hysterium mytilinum* Pers., *Syn. Meth. Fung.*, p. 97. 1801) is suggested.

The pycnidial stage obtained in culture has not been found on *Pinus sylvestris*, but a small collection was obtained from recently dead, attached twigs of *P. Strobus*. The black pycnidial clusters (Figs. 33 C-D) are intracorticular, with erumpent ostiole papillae. They measure 250 to 300 (400) μ in diameter and 200 to 250 μ in height. The number of papillae to each fructification ranges from one to fifteen, with an average of eight to twelve. The papillae average 30μ in the median diameter and are scarcely as high as broad. At maturity a fructification may have a single conidial cavity common to all the papillae or, if in the development of the fructification the coalescence of cavities has not been completed, several cavities may be apparent. The wall of the fructification is complete, subcarbonaceous, 10 to 15 (20) μ thick, and is parenchymatous with four or five to eight or ten cell layers, the outer cells opaque, and the inner, hyaline and sporogenous. The spore-bearing cells are globular to obovate, $3-4 (5) \times 2-3 \mu$,

although occasionally more elongate, and they abstrict the pycnidiospores singly. The spores are hyaline, acrogenetic, ovate-inequaliteral to suballantoid, and measure $2-2.4 \times 1-1.3 \mu$. Single-pycnidiospore cultures from this material produced mycelia identical with those of single-ascospore cultures. After three months several of such cultures on the Leonian medium had produced the Papulospora stage, but only one culture on oatmeal agar had returned the pycnidial stage.

A pycnidial fructification of the foregoing description shows certain characters of the form genus *Dothiorella*, but differs from it in the development of a single cavity at maturity.

Lophium dolabriforme Wallr.

No. 196. On dead twigs on shrub, *Salix* sp., at 9,000 ft., north of Grand Lake, Colo., Aug. 27, 1928. Collected by M. L. Lohman.

Hysterothecia 0.75 to 1.5 mm. in height, 0.5 to 0.7 mm. in length, black, carbonaceous, fragile, ligulate with the typical corrugations, and mostly free from the substratum except for the brown, rhizoidal, hyphal strands; asci $300-360 \times 8-10 \mu$; spores in young asci nearly as long as the ascus, but at maturity fragmenting into sections averaging $12 \times 2 \mu$, at first yellow and 1-septate, then yellow-brown and 3-septate.

The best description of the European fructifications has been given by Rehm (36, p. 27). A comparison of his measurements of the hysterothecia with those given by Ellis (11, p. 124) and with those of the Colorado material indicates that the American form is considerably smaller.

Vegetative cultural characteristics. — All cultures of this species showed extremely slow growth (Table I). Marginal hyphae are dark, slightly immersed, sparingly branched, and grow radially outward in a straight course with the branches arising at an acute angle and growing immediately outward in parallel courses. The hyphae of rhizoidal strands and of the prosenchymatous tissue of the fruiting structures in collected material suggest this manner of growth. On agar media the organism produces a loose, prosenchymatous surface web several millimeters in depth. A gray

TABLE I

APPROXIMATE RADIAL GROWTH ATTAINMENTS, RELATIVE TO
TEMPERATURE, ON OATMEAL MEDIUM AT THE END OF EIGHT WEEKS

10° C.				SPECIES	22-25° C.			
75 mm.	50 mm.	25 mm.	0		0	25 mm.	50 mm.	75 mm.
				LOPHIUM				
-	-----	-----		L. mytilinum	-----	-----	--	
		---		L. dolabriforme	-			
				GLONIUM				
-	-----	-----		G. stellatum	-----	-----	-----	
		-----		G. simulans	-----	-----	--	
		-----		G. parvulum	-----	-----		
		-----		G. lineare	-----	--		
				MYTILIDION				
		-	-----	M. tortile	-----	--		
		--	-----	M. laeviusculum	-----	-----	--	
		-----		M. decipiens	-----	--		
		-	-----	M. resinicola	-----	-----		
		-----		M. Thujarum	-----	--		
				HYSTERIUM				
		---		H. pulicare	-----	--		
		-----		H. angustatum	-----			
		---		H. insidens	-----			
				HYSTEROGRAPHIUM				
		-----		H. kansense	-----			
		-----		H. minutum	-----	-----	---	
				H. Mori	-----	-----	-	
		-	-----	H. Lesquereuxii	-----	-----	-	
		-----		H. formosum	*			
		---		H. vulvatum	-----			
		--	-----	H. Fraxini	-----	--		
				GLONIOPSIS				
		--	-----	G. brevisaccata	-----	-----	--	
		-----		G. Gerardiana	-----	--		
				HYSTEROPATELLA				
		---		H. Prostii	-----	--		
		---		H. clavispora	-----	--		

* No radial increase, but cultures remained viable; sclerotic development.

("light mouse gray," becoming "olive-brown" to "hair brown") aërial mycelium is loosely interwoven and averages one millimeter in depth. Microscopically, the twisted, sparingly branched hyphae of this mycelium are close-septate, torulose to catenulate, yellow-brown, and measure 3 to 4 μ in diameter. Similar torulose hyphae (Fig. 32 *F*) arise as black, semisuperficial clusters on the marginal mycelia of old cultures arrested in growth. If one considers the individual cells as conidia, then one is here concerned with conidial chains which do not fragment readily and which possibly conform to the dematiaceous *Gyroceras* type. The surface of an old culture becomes covered with these filaments and the culture appears darker ("blackish mouse gray") than described above.

Sclerotial bodies (Fig. 32 *G*) 10 to 20 μ in diameter are common on the surface of oatmeal cultures. Neither the catenulate filaments nor the sclerotial bodies are associated with the writer's collected material, but it is scant. If sclerotia are produced in the field they would probably precede the perfect stage and, if superficial, would disappear early.

In this report this is the only species in which a tissue culture has been given consideration. The ascospores did not germinate; stock cultures carried originated in the rejuvenescence of hyphae of the rhizoidal strands. However, the rarity of the organism warrants inclusion of these brief culture notes, which can stand only as circumstantial evidence until the fungus is grown from single-spore isolations.

Glonium stellatum Muhl. ex Fries

No. 195. At base of old stump, Boston, Mass., March 26, 1927. Collected by Dr. L. E. Wehmeyer. No. 265. On much-decayed *Quercus log*, Livingston County, Mich., Aug. 13, 1930. Collected by M. L. Lohman.

Asci 70–90 $\times$ 8–9 μ ; spores (20) 22–24 (27) $\times$ (4.5) 5–6 μ , hyaline, 2-celled, elliptic-fusiform, slightly curved with acuminate ends.

G. stellatum Muhl. ex Fries is considered the type of the genus which Muhlenberg proposed in 1813 (*Cat. Pl. Am. Sept.*,

p. 101). De Notaris (6), the first person to amend the old generic description to include species with simple hysterothecia not seated upon a byssoïd subiculum, placed emphasis on spore characteristics. He argued (*op. cit.*, p. 25) that *G. stellatum* is atypical for the forms with 2-celled hyaline spores. It was in consideration of these same points that Von Höhnelt (19) erected the subgenus *Psiloglonium*, and that Petrak (34), in connection with additional characters of questionable value, raised *Psiloglonium* v. H. to generic rank, retaining it in the *Hysteriaceae*, and intimated that *G. stellatum* Muhl. and other species exhibiting a byssoïd subiculum are much out of place in Von Höhnelt's family. Petrak described the spores of *G. stellatum* as two-celled or more.

Those who have reported the spores to be more than 1-septate have undoubtedly observed spores that were in an arrested early stage of germination. Germinating spores of the four species of *Glonium* presented here have been compared and figured by the writer (31).

Vegetative cultural characteristics. — Vigorous mycelia are a blue-black ("plumbeous black" or "dusky purplish gray"). The fungus produces a "dark violet gray" coloration of the Leonian medium. A feltlike surface weft 1 to 1.5 mm. deep is formed by parallel, dichotomously branched, radially directed, coarse hyphae. A loose superficial weft 2 to 5 mm. deep is composed of granular-walled, coarse hyphae, which soon become brown. The surface layer produced in cultures is apparently homologous to the blue-black crust on collected material, and the superficial weft corresponds to the brown subiculum upon which the fructifications are usually seated. Of all the species cultured this showed greatest vegetative vigor (see Table I). The fungus was cultured on cork-decoction agar, on oak wood, and on granulated cork, with various nutrient concentrations. These media reduced vegetative growth in varying degrees, but none of the cultures produced the pycnidial stage observed in field material.

Observed associations. — The writer discovered a pycnidial stage (Pl. XXXIV, Fig. 5) associated with the perfect stage on a much-decayed oak log in low ground bordering a tamarack swamp. A blue-black area of several square feet was composed of numerous

imperfect fructifications. The pycnidia (Figs. 34 A-B) are of the *Sphaeronaema* type and differ from those described by the writer (30) for *G. parvulum* in that they are loosely aggregated and not cespitose, being more or less equally scattered, and in that they are more robust, with slightly larger sporulating cells. The latter measure $6-11 \times 2.5 \mu$. The pycnidia measure (150) 170 to 200 (215) μ in width and (100) 120 to 140 (180) μ in height, exclusive of the beak. Beaks are 50 to 200 μ in length, averaging

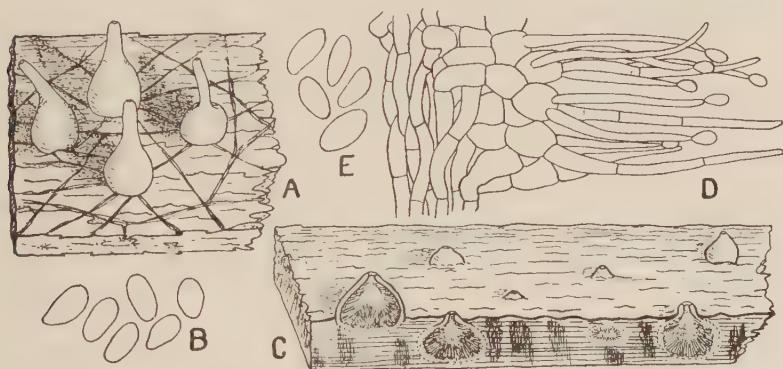


FIG. 34. A-B, *Glonium stellatum*; the *Sphaeronaema byssoideum* stage. A, pycnidia, $\times 30$; B, pycnidiospores; all from field material. C-E, *Glonium lineare*; pycnidial stage from field material. C, habit of pycnidia, $\times 30$; D, portion from lateral wall showing the cells of the wall and the sporulating cells; E, pycnidiospores

140, and have an average median diameter of 60μ . The pycnidia are superficial upon the loose subiculum in the less-exposed areas, whereas on exposed surfaces they are superficial upon the thin black crust. The stage name *Sphaeronaema byssoideum* Lohman, status novus *Glonii stellati*, is suggested. For other details the description of *Sphaeronaema parvulum* (30, p. 152) is sufficient. All attempts to stimulate germination of the pycnidiospores were unsuccessful.

Glonium simulans Ger. (Pl. XXXIV, Fig. 4)

No. 30. On decorticated wood of *Tilia americana* L., Ann Arbor, Mich., Nov. 15, 1928. Collected by M. L. Lohman.

G. simulans is not uncommon about Ann Arbor on old wood of *Quercus*, *Tilia*, and *Ulmus*, and on old stumps of *Juglans* and *Prunus*. The spores are elliptic-biconical and measure $14-16$ (18) $\times$ (4.5) $5-6$ μ , somewhat larger than Ellis (12, p. 683) described them.

Vegetative cultural characteristics. — Growing mycelia of *G. simulans* are gray ("dawn gray," soon becoming "storm gray") and the superficial weft retains this color for several months. The feltlike surface layer is darker, especially on the Leonian medium, and is composed of irregularly branched, closely interwoven, brown, granular-walled hyphae and coarse, black strands of parallel, anastomosing filaments. On the Leonian medium these strands occasionally become aërial and branch dendroidally. The "purple-drab" coloration of the oatmeal medium extends as much as two centimeters beyond the margin of the culture. In its mode of spore germination (31) and in its cultural characteristics, the species is intermediate between *G. stellatum* and *G. parvulum*. It approaches the former in its rate of growth, texture of the three layers on agar media, granular-walled hyphae, and straight, radially directed parallel strands. In the color of the young mycelia and in the distinct coloration of the oatmeal medium it suggests *G. parvulum*. All the cultures remained sterile, and pycnidia were not observed in the field material.

Glonium parvulum (Ger.) Cooke

No. 12. On decorticated trunk of *Ulmus fulva* Michx., Ingham County, Mich., Oct. 14, 1928. Collected by M. L. Lohman.

The original material used for culture notes on this species has been described and figured by the writer (30).

Vegetative cultural characteristics. — *G. parvulum*, in its cultural characteristics, is distinct from the two preceding species. The young mycelium is at first whitish, but soon becomes pinkish and then "spinel red" to "hellebore red." At six to ten weeks cultures are erumpent, with an irregular margin, and a single culture may show various colorations, including "vinaceous," "pinkish cinnamon," "vinaceous-fawn," and "avellaneous." In the light the

oatmeal medium is greatly discolored ("purplish vinaceous" or "purple-drab").

Cultural fructifications. — A pycnidial stage has been obtained on numerous single-spore and single-ascus cultures under various conditions. Single germinating pycnidiospores were isolated and these returned the pycnidial stage. For a detailed description of pycnidial development and discussion on the taxonomic position of the pycnidial stage the reader is referred to an earlier report (30). The name *Sphaeronaema parvulum* was suggested, and the description of the pycnidial stage was presented as a supplement to that of the perfect stage. The description is referable to *Sphaeronaema parvulum* Lohman, status novus *Glonii parvuli* (*Hysterium* (*Glonium*) *parvulum*, Gerard, *Bull. Torr. Bot. Club*, 5: 40. 1874).

The diagnosis was based upon development from single ascospores on various culture media and on oak chips on the surface of an oak-infusion medium. It was stated (*op. cit.*, p. 150) that pycnidia obtained from single-conidium (pycnidiospore) cultures were merely conic-ostiolate, but typical pycnidia have since been obtained on such cultures.

Sphaeronaema parvulum and *S. byssoideum* are near the *Pleuronaema* type of the Von Höhnelt system (20). They differ from it in the thinner pycnidial wall, in the smaller and not definitely allantoid spores, and, primarily, in that the spores are not pleurogenetic as well as acrogenetic.

Observed associations. — After the author published the description of the pycnidial stage obtained in culture (30), a small collection of *G. parvulum* (Lohman, No. 240; Univ. of Mich. Herb.) was made on much-decayed oak, and it presented the pycnidial stage identical in all respects with that already described and figured by the writer.

Glonium lineare (Fr.) De Not.

No. 255. On weathered slab of *Fraxinus nigra* Marsh., Livingston County, Mich., July 27, 1930. Collected by M. L. Lohman.

Asci 55–65 $\times$ 12–14 μ ; spores 2-celled, hyaline, 13–16 $\times$ 6–8 μ , oblong and the upper cell well rounded.

Vegetative cultural characteristics. — *G. lineare*, in its vegetative characteristics, differs decidedly from the three preceding species. The superficial and surface layers together are less than one millimeter deep. The sparse aërial mycelium is white, becoming gray on cultures that have developed for several months. The surface layer is at first light in color, but soon becomes a sordid green ("Andover" to "dark ivy green"), and this persists several months. Then numerous stromatic erumpent areas, becoming 0.5 to 1 mm. in diameter and later confluent, form progressively from the central region outward and blacken the culture. After three months the pycnidial cavities described below were abundant in the stromatic areas and in isolated darkened areas on the margins. Coarse vesicular hyphae are abundant in the surface layer and brown, terminal or intercalary vesicles 8 to 12 μ in diameter are numerous in old cultures. The species grows very slowly.

Cultural fructifications. — Three to eight independent cavities arise beneath each stromatic elevation, apparently by the dissolution of large vesicular hyphae. A wall about each cavity is first discernible as several layers of hyaline, long-celled filaments oriented in a direction perpendicular to the surface of the stroma. This tissue later becomes dark, averages 10 to 20 μ in thickness, and the inner filaments branch inwardly to form short, swollen cells, each of which bears a number of tufted sporulating cells and occasionally a sterile septate filament 40 to 60 μ in length. Individual sporulating cells are simple, curved at the base, measure $15-30 \times 2-2.5 \mu$, and abstrict the hyaline pycnidiospores singly from their tips. The spores are elliptic-oblong to ovate-inequilateral, and measure $2.5-3 \times 1.5-2 \mu$. The cavities increase until their walls meet, but apparently they do not coalesce. True, ostiolate pycnidia do not develop, and the conidial discharge to the surface of the stroma is irregular.

Observed associations. — The thin, black stroma on wood is accompanied by numerous pycnidia (Fig. 34 *C-E*) and this condition precedes and borders the hysterothecial stage. The globular, black, carbonaceous, conic-ostiolate pycnidia arise within the wood and beneath the stroma and at maturity become erum-

pent by their short papillae. It is possible, however, to find pycnidia entirely superficial upon the stroma. In the latter condition pycnidial walls are complete, small-celled prosenchymatous, and 15 to 30 μ thick, whereas in the former types blackening occurs only in the exposed papillate portions, and the lower lateral and basal walls are hyaline and poorly developed. The spore-bearing cells and spores conform to the type obtained in culture. Pycnidia measure (150) 200 to 300 μ in diameter.

This type of fructification falls in the *Plenodomus*-*Dothiopsis*-*Phomopsis* group of Diedicke's system (8). These form genera are distinguished with difficulty, and intermediate forms are to be expected. *G. lineare* pycnidia approach *Phomopsis* in the type of spore-bearing cell and in the spatial relations of the wall to the substratum, but in their spores and in the sclerotic development of the wall they are of the *Plenodomus* type, if the diagnostic characters of Diedicke are used (7).

The pycnidial stage of this species (see p. 232) has recently been described as *Hysteropycnis globularis* Hilitzer (18, p. 151).

Mytilidion tortile (Schw.) Sacc. (Pl. XXXIV, Fig. 1)

No. 262. On bark of living *Juniperus virginiana* L., Washenaw County, Mich., Aug. 13, 1930. Collected by M. L. Lohman.

Hysterothecia loosely gregarious and inordinately arranged, superficial, black, occasionally longitudinally striate, (0.5) 0.7 to 1.2 (1.5) mm. in length, 0.2 to 0.3 mm. in breadth, the height equaling or slightly exceeding the width, subconchiform and rounded above or elongate with pointed ends and then usually acutely keeled; walls prosenchymatous, thin, carbonaceous, and fragile; asci slender-clavate, (65) 75-85 $\times$ 6-8 μ , the inner ascus becoming 115 to 130 μ in length on expansion; paraphyses abundant, 2 μ in diameter, hyaline, septate, irregularly branched above, forming a yellowish epithecium; spores obliquely uniseriate, clear yellow-brown to slate-brown, 3-septate, 13-16 (18) $\times$ 4-5 μ or very rarely 20 μ long and 4-septate, mostly oblong-fusiform and slightly curved, with obtuse ends and slight constrictions.

This description is given since serious discrepancies occur

among those that have been published under the name of *M. tortile* (Schw.) Sacc. It is based upon collected material, upon Ellis and Everhart 2152 and 2829, North Am. Fungi, and upon 2065 in the herbarium of Schweinitz at Philadelphia.

Ellis (12, p. 688) correctly disposed of his *M. Juniperi* E. & E. (*Journ. Myc.*, 4: 57. 1888) by placing the name in synonymy. Rehm (38, p. 110) altered his earlier description (36, p. 23), making it conform to the Ellis and Everhart distributions, and at the same time he placed *M. decipiens* (Karst.) Sacc. in synonymy. The disposition of the latter must be accepted provisionally in view of the writer's notes presented under that name.

It must not be forgotten that Schweinitz (43, p. 50) described his *H. tortile* on Carolina material (No. 250, on bark of *Juniperus virginiana*) and that no one has stated definitely that Schweinitz 250 and 2065 are identical microscopically. Duby (9, p. 38) described the spores of Schweinitz 250 as being light brown, 3-septate, and three to four times as long as broad, whereas Rehm's (35, p. 187) revision notes refer only to "*H. tortile* Fr. ex herb. Hooker," which Rehm labeled "Unbrauchbares Exemplar."

Vegetative cultural characteristics. — In cultures the young marginal hyphae are dark ("mummy brown" to "fuscous black"); a loose, thin, superficial layer lighter in color ("cinnamon-brown") develops tardily; and an unusual discoloration ("vinaceous-fawn" to "cinnamon-drab") of the oatmeal appears early and persists. Single-spore and single-ascus cultures produced a pycnidial stage on the Leonian medium and on cork-decoction agar.

Cultural fructifications. — Pycnidia (Figs. 35 A-B) are single or clustered in the aërial mycelium and densely clustered in stromatic areas of the surface layer. They are globular, conic-ostiolate, 90 to 150 (175) μ in diameter, and have a complete, thin, fragile, and decidedly carbonaceous wall. The wall is 10 to 20 μ in thickness, with the outer third portion opaque-carbonaceous, and the inner layers hyaline-prosenchymatous. Young pycnidia show a central portion of interwoven vesicular hyphae, and spore production apparently begins without a definite cavity being formed. Later, the pycnidia contain an agglutinated mass of

spores and disintegrated hyphae held in a mucilaginous oily matrix, which imbibes water very slowly. In old pycnidia the spore-bearing cells are obovate and measure $4-6 \times 3 \mu$. They are arranged in an irregular layer upon an indefinite hymenial base (Fig. 35 F). The pycnidiospores are acrogenetic, hyaline, subglobose, 2μ in diameter, and appear to be abstricted singly. Hilitzer (18, p. 135)

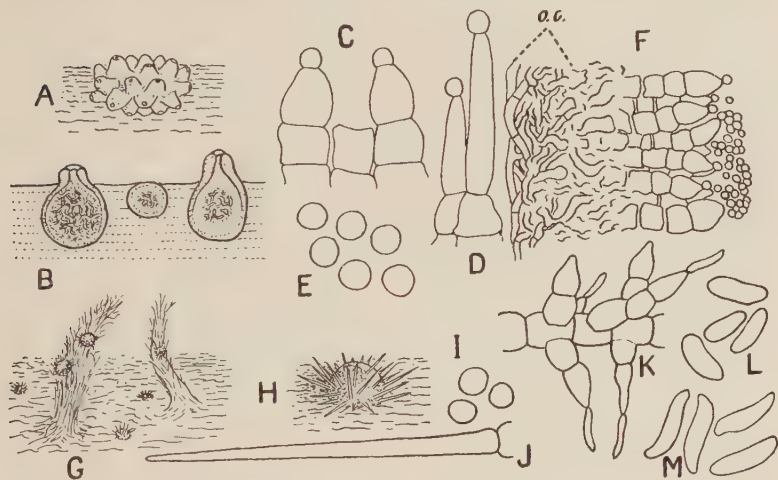


FIG. 35. A-F, *Mytilidion tortile*; pycnidial stage obtained in culture. A, pycnidial cluster on agar medium, $\times 25$; B, sectional view of pycnidia in the surface layer; C, D, spore-bearing cells (D, uncommon); E, pycnidiospores; F, portion from lateral wall showing cells of the wall and spore-bearing cells (o.c., region of opaque cells). G-M, *Mytilidion decipiens*; pycnidial and hyphomycetous (K-M) stages obtained in culture. G, erect mycelial tufts and pycnidial fructifications on agar medium, $\times 30$; H, pycnidium, $\times 100$; I, pycnidiospores; J, a spine from the surface; K, conidiophores of the hyphomycetous stage; L, conidia from the surface layer; M, conidia from the hyphae of the superficial layer and the erect tufts

has described a similar pycnidial stage in connection with *M. aggregatum* Duby.

Observed associations. — Fragile, carbonaceous, globular pycnidia 75 to 100 μ in diameter are abundant on collected material and on "Schweinitz 2065." They are single, ostiolate, and

erumpently superficial. Numerous examinations did not reveal a hymenial content that could be satisfactorily interpreted, although an agglutinated mass of indefinite structure was occasionally observed.

Mytilidion laeviusculum (Karst.) Sacc.

No. 281. On unexposed surfaces, much-decayed log of *Larix laricina* (Du Roi) Koch, Livingston County, Mich., Sept. 18, 1930. Collected by M. L. Lohman.

Hysterothecia $0.4-0.5 \times 0.25$ mm.; asci $50-65 \times 6-7$ μ ; spores $18-22 \times 2.5$ (3) μ , spindle-shaped and 3- or 4-septate.³

Vegetative cultural characteristics. — Cultures of this fungus differ from those of *M. tortile* in that growth is far more rapid, the marginal mycelium is darker ("sooty black"), the superficial layer is a deeper brown "Prout's brown" to "bister"), and there is no discoloration of the oatmeal medium. Cultures resemble closely those of *G. stellatum*, but radial growth is by repeated irregular branching of uniform, interwoven hyphae, and not by the straight paralleling hyphae of that species. Terminal and intercalary brown vesicles are abundant in the surface layer. Imperfect stages are unknown.

Mytilidion decipiens (Karst.) Sacc.

No. 302. On inner bark, old stumps of *Picea canadensis* (Mill) BSP., Dickinson County, Mich. (N.P.), Sept. 3, 1930. Collected by A. H. Smith.

Hysterothecia $0.3-0.5$ (0.6) $\times 0.1-0.2$ mm., about as high as broad, with the swollen central portion faintly striated and the acuminate, smooth ends free from the substratum; asci $75-90 \times 8-10$ μ ; paraphyses hyaline, much-branched, and interwoven above; spores $15-21 \times 5-6$ μ , clear yellow-brown, subbiseriate, 3-septate, unconstricted, slightly curved, oblong-elliptic with

³ These measurements are practically identical with those given by Karsten (22, p. 261) in his original description of *Lophium laeviusculum*. Individual fruits of *M. tortile* are noticeable to the naked eye, whereas the aggregated hysterothecia in the material herein referred to *M. laeviusculum* are seen only as a purple-black coloration of the substratum.

obtuse ends, the lower cell in most specimens narrower than the upper.⁴

Rehm (38, p. 110), listing Karsten's Fung. Fenn. 767, placed *M. decipiens* (Karst.) Sacc. in the synonymy of *M. tortile*. Since that number has not been studied by the writer the material at hand can be only questionably referred to *M. decipiens*. However, in its cultural characteristics and in its morphology, the writer's material indicates an organism distinct from *M. tortile*. In view of the state of confusion now existing in the taxonomy of the group, it is best to refer the data tentatively to Karsten's species until the validity of Rehm's disposition of that species is further investigated.

Single-ascus isolations were not obtained for this species. All single-spore cultures originated with the isolation of germinating spores from several plates prepared from the same spore suspension. The unexpected character of the resulting cultures demands that this species be restudied with additional isolations. Since all cultures were identical and apparently the expressions of a single organism, the results are given herein, pending a further investigation of the cultural habits of this collection.

Vegetative cultural characteristics. — Young mycelia are white, with a very thin superficial growth; the radial growth is confined to the medium. The hyphae are short-septate, 3 μ in diameter, with variously swollen cells, and anastomose in thick strands; they branch profusely and irregularly, and show a dense-oily content. The mycelium soon becomes pale orange-yellow ("ochraceous-buff"), and the Leonian and oatmeal media are readily discolored "honey-yellow." When mass conidial production begins on the surface the culture becomes darker ("orange-cinnamon"). On the Leonian medium at three months the surface layer becomes dark brown. Old cultures also show thick, erect tufts of anastomosed hyphae, which bear numerous conidia.

Cultural fructifications. — The aërial hyphae bear clusters of

⁴ The description indicates that the spores are intermediate in character between those of *M. tortile* and *M. laeviusculum*. Karsten's original description (22, p. 261) of *Lophium decipiens* (Fung. Fenn. 767) suggests a fructification with the characteristics related above, except that the hysterothecia are described by Karsten as being somewhat smaller.

long-elliptic to curved or sigmoid conidia (Fig. 35 *M*) on intercalary swollen cells. These conidia are subhyaline under the microscope, orange in mass, and measure $5-8 \times 1.5-2 \mu$. Within the surface layer hyphal cells branch laterally to form tapering conidiophores 6 to 10μ in length, which abstrict conidia from their tips. These conidia (Fig. 35 *L*) are elliptic to inequilateral and measure $4-6 \times 1.5-2 \mu$.

Pycnidia (Figs. 35 *G-H*) arise singly in the erect hyphal tufts, and on the margin in old cultures they develop within the surface layer. The walls are small-celled parenchymatous, membranous-carbonaceous, and the outer cells develop unseptate, brown, pointed bristles 40 to 60μ in length. Young pycnidia show an agglutinated hyaline, central portion of indefinite structure, apparently densely packed with oil. Subglobose to short-oblong hyaline pycnidiospores 1.5μ in diameter or $2 \times 1.5 \mu$ are produced and retained within an oily matrix. Definite sporulating cells have not been observed. The fructification is of the *Pyrenochaeta* type in the sense of Diedicke (8). The indefinite manner of pycnidiospore production would refer it to the *Sclerochaeta* type of the Von Höhnelt (20) system.

The imperfect stages have not been observed in collected material.

***Mytilidion resinicola* Lohman, sp. nov. (Fig. 36)**

Hysterothecii subgregariis et inordinate dispositis, superficialibus, rectis, nigris, rugosi-punctatis vel indistincte longitudinaliter striatis, 0.75–1.25 mm. longis, 0.25–0.3 mm. latis, subconchiformibus cum labiis acutissimis vel depressi-hysteriformibus, interdum triradiatim ramosis, plerumque ad crustam nigram carbonaceam hypharum dense intertextarum conjunctis, textura prosenchymatosis, fragilibus carbonaceis; ascis clavatis, octosporis, $100-110 \times 15 \mu$; membrana ascorum crassa; paraphysibus filiformibus, septatis, multiramosis et sursum intertextis; sporidiis $24-26 \times 8-9 \mu$, distichis vel oblique monostichis, oblongo-ellipsoideis, luteofuscis vel fuligineis et fere opacis, 3-septatis, ad septa valide constrictis.

Ad corticem resinose in truncis mortuis *Laricis laricinae*, solum ad basim ramorum vetustorum. Livingston County, Mich., Aug. 6, 1930. Specimen typicum in Herb. Univ. Mich.

Hysterothecia loosely gregarious and lying in various directions, superficial, straight, black, rugose-punctate to faintly longitudinally striate, $0.75\text{--}1.25 \times 0.25\text{--}0.3$ mm., subconchiform with a sharp ridge or depressed hysteriform, occasionally 3-radiate, accompanied by a compact, black carbonaceous crust of close-septate, torulose, interwoven hyphae; walls prosenchymatous, thin, carbonaceous, and fragile; asci double-walled, $100\text{--}110 \times 15$ μ ; paraphyses hyaline, septate, much branched, and interwoven above; spores $24\text{--}26 \times 8\text{--}9$ μ , elliptic-oblong with rounded ends, 3-septate and deeply constricted at the septa, yellow-brown to dark fuscous and nearly opaque, and biseriate, becoming obliquely uniseriate in the extended inner ascus.

On resinous exudation and the surrounding bark, confined to knots on fallen and erect dead trunks of *Larix laricina* (Du Roi) Koch, Livingston County, Mich., Aug. 6, 1930. Collected by M. L. Lohman (No. 260). Type in the herbarium of the University of Michigan.

The asci and spores are similar to those of *Hysterium angustatum* Alb. & Schw., but the hysterothecia have the form and texture of Mytilidion. In its diagnostic features the fungus approaches *M. aggregatum* (DC.) Duby (9, p. 34) and *M. rhenanum* Fuckel, as used by Rehm (36, p. 24). It differs from the former in that the spores are larger with all of the cells colored, and from the latter in that the spores are broader and constricted. According to Rehm (*op. cit.* and 35, p. 181) the status of these two species has not been determined with any satisfaction.

Vegetative cultural characteristics. — In respect to the vegetative character, cultures of this species closely resemble those of *M. tortile*. The young mycelia, however, are gray rather than brown, the pink discoloration of the oatmeal does not persist, and growth is more rapid. Only single-ascus isolations were obtained, and these have remained sterile.

Observed associations. — The pycnidia (Fig. 36 E) accompanying the hysterothecia are ostiolate-papillate, 200 to 250 μ in diameter, smooth and globose with a prosenchymatous, fragile-carbonaceous, complete wall 5 to 8 μ thick. The simple sporulating cells measure $5\text{--}10 \times 2.5$ μ and abstrict singly from their tips;

hyaline, subglobose pycnidiospores, 2 to 2.5 μ in diameter. The spores are held in a mucilaginous matrix and on drying form a white concretion at the tip of the papilla. This type of fructification can be referred to the form genus *Aposphaeria*.

Mytilidion Thujarum (C. & P.) Lohman, comb. nov. (*Hysterium Thujarum*, Cooke, *Disc. of U. S.*, p. 33. 1875).
(Pl. XXXIV, Fig. 2).

No. 306. On inner bark, old stumps of *Thuja occidentalis* L., Brown County, Wis., Sept. 8, 1930. Collected by A. H. Smith.
Hysterothecia 0.4–0.8 (1) $\times$ 0.25–0.4 mm.; asci 140–170 $\times$

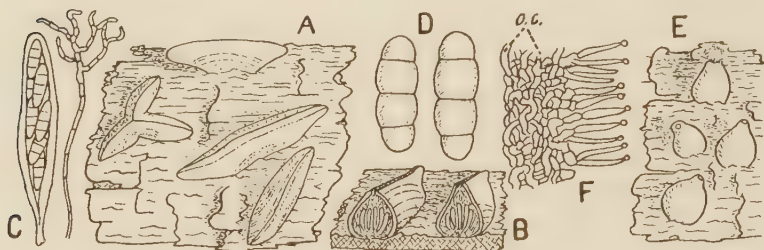


FIG. 36. *Mytilidion resinicola*; from field material. A, hysterothecia, $\times 20$; B, cross-section view; C–D, hymenial elements; E, pycnidia, $\times 20$; F, portion from lateral wall showing cells of the wall, the slender-clavate spore-bearing cells and the minute, subglobose pycnidiospores (o.c., region of opaque cells)

15–18 μ ; spores 34–40 $\times$ 10–12 μ , rich brown, slightly curved, pointed below, 4- to 5 (6)-septate, constricted at the septa, with the third cell from the upper end swollen. The type (?), "*H. thuiarum* C." at Kew, has been examined by the writer. That material is described by Bisby (as cited in note 1).

Young hysterothecia are black and shining, vertically compressed, with pointed ends and a sharp ridge, and as they develop the crest becomes obtusely rounded and more or less distinctly longitudinally striate. Of greater importance in the proper classification of this species is the fact that even at maturity the walls of the hysterothecium are thin and fragile, with the structure of *Mytilidion*.

Vegetative cultural characteristics. — The species is distinguished from *M. tortile* in culture by the more dense, and deeper brown, superficial layer and by the close, dendroidal branching of the hyphae in this and the surface layer. Cultures on various media, held under the same conditions as those of *M. tortile*, did not produce pycnidia. Empty pycnidial fruits comparable to those observed in *M. tortile* are abundant in the collected material which shows hysterothecia in all stages of development.

Hysterium pulicare Pers. ex Fr.

No. 198. On bark of *Ulmus americana* L., Ann Arbor, Mich., April 4, 1930. Collected by M. L. Lohman.

Adequate descriptions of the species have been given by Rehm (36) and by Ellis (12). The writer's studies, however, indicate that the coloration of the end cells of the spores is variable within a given hysterothecium. Typical germination of *H. pulicare* spores is by one or two germ hyphae from each of the terminal cells. Many spores were studied and germination of the brown central cells was estimated as less than 5 per cent. Germination in these cells and in the occasional, brown terminal cells was considerably delayed, whereas in the brown terminal cells of *H. angustatum* spores it proceeded readily. The germ tubes of *H. pulicare* ascospores are densely oily-granular.

Vegetative cultural characteristics. — Cultures are black and present a smooth, shining surface due to the absence of the superficial layer. A loose, thin, gray superficial layer of very delicate hyphae does appear on the oatmeal medium after five or six months. The origin of these hyphae is twofold: (1) the germination of pycnidiospores to produce the more dense mycelial clusters; (2) the germination of thick-walled resting cells of the surface layer to produce an even, widespread, loose, mycelial weft. Various cells of the hyphae of the surface layer become pyriform or globular and store a tremendous amount of oil. They may be single and terminal on short branches, or intercalary and occurring either singly or in chains. Olive-brown, thick-walled cells of this type attain a diameter of 8 to 12 μ .

Cultural fructifications. — Pycnidiospores were not observed

in cultures on the Leonian medium at 20 to 25° C., although pycnidial cavities were produced sparingly on this medium at 10° C. On the oatmeal medium at the higher temperatures sporulating pycnidial cavities were fairly common by the fifth or sixth month, and at that time in the cultures at 10° C. pycnidiospores were being produced in abundance in well-developed pycnidia. The illustrations (Figs. 37 B-C) and description of this stage pertain to the pycnidia obtained in the latter cultures.

Pycnidia 75-150 μ in diameter arise within the surface layer and become ostiolate-erumpent. They are single or clustered,

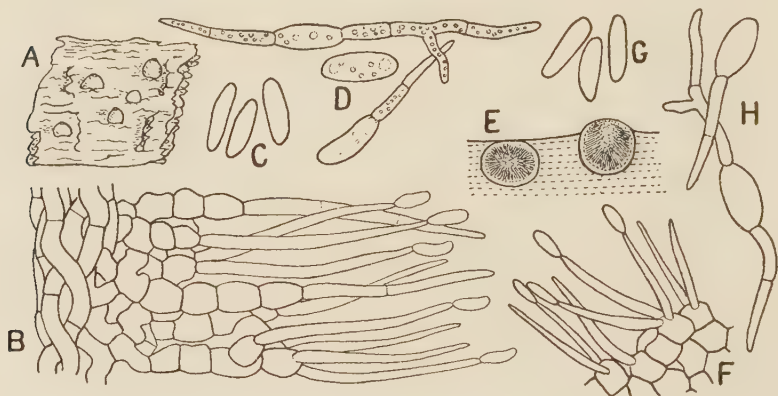


FIG. 37. A-D, *Hysterium pulicare*; pycnidial stage. A, pycnidia on *Quercus* bark, $\times 30$; B, portion from lateral wall showing cells of the wall, spore-bearing cells and pycnidiospores (typical for field material and for pycnidia obtained in culture); C, pycnidiospores from cultures; D, germinating pycnidiospores from field material. E-H, *Hysterium insidens*; pycnidial stage. E, pycnidial cavities in the surface layer on agar medium, $\times 70$; F, pycnidiospores and spore-bearing cells; G, pycnidiospores; H, early germination of the same; all from cultures

and each has a single cavity. Their walls are membranous, with the outer layers loose-prosenchymatous. Hyphae of this tissue branch inwardly as tapering filaments with globular basal cells, and each filament is terminated by a slender sporulating cell. The filaments extend through an indefinitely small-celled, parenchymatous, hyaline layer, which gives rise to numerous slender sporulating cells measuring (15) 25-50 $\times$ 1.5-2 μ . The

hyaline, cylindric-inequilateral pycnidiospores are acrogenetic and measure $4-5.5 \times 1.5$ (2) μ . Pycnidiospores in various stages of germination have been observed. The germ-tube hyphae have a densely granular protoplasmic content as noted for the germinating ascospores.

Observed associations. — The original material for these cultures does not show a pycnidial stage. Another collection on *Quercus* bark is accompanied by numerous black, membranous, globular, superficial, ostiolate pycnidia (Fig. 37 A), 50 to 75 μ in diameter, with pycnidiospores and spore-bearing filaments of the type described above. Pycnidiospores from this material were germinated (Fig. 37 D). This confirms Brefeld's (2, p. 47) statement concerning Möller's studies on this species. The pycnidial stage (see p. 232) recently described for this species by Hilitzer (18) as *Hysteropycnis occulta* is similar.

Hysterium angustatum Alb. & Schw.

No. 309. On bark and wood, living *Betula alba* var. *papyrifera* (Marsh.) Spach., Brown County, Wis., Sept. 8, 1930. Collected by A. H. Smith. This material is tentatively referred to *H. angustatum*.

Hysterothecia (0.6) $0.8-1.2 \times 0.4$ mm., oblong, rounded above with a prominent fissure, rugose-punctate to faintly longitudinally striate, straight to subflexuous, densely aggregated, mostly irregularly oriented, and superficial upon a greenish black crust dense with algal cells; asci $105-120 \times 10-16$ μ , including the stalk; paraphyses filiform, much branched above and forming an epithecium; spores $22-26 \times 6.5-8$ (9) μ , biseriate, elliptic-fusiform, and slightly curved, rich brown and 3-septate with the cells swollen.

Ellis (12) and Rehm (36, 38) have indicated the difficulty with which *H. pulicare* and *angustatum* are separable, and Rehm has questioned the specific value of the latter. The writer's material combines beautifully the diagnostic features of the two species. Yet in its cultural character the fungus does not suggest *H. pulicare* in any respect.

Vegetative cultural characteristics. — Growing mycelia are white

and cultures remain light for several weeks. The surface layer then darkens ("Andover green"), and this color is pronounced until hidden in old cultures by a deep superficial layer of coarse, straight, sparingly branched hyphae, "dark olive-gray" in mass. Erect, green, dendroid tufts of anastomosed filaments from the surface layer occasionally break through the superficial weft. The oatmeal medium is discolored to "light brownish vinaceous." In mycelial color changes, rate of growth, and discoloration of the medium the cultures resemble those of *H. insidens*.

Hysterium insidens Schw. (Pl. XXXV, Fig. 3)

No. 102. On *Quercus palings*, Preble County, Ohio, Sept. 11, 1929. No. 257 (Septonema stage): on old rail (*Quercus* ?), Livingston County, Mich., July 26, 1930. No. 308 (hysterothecial and Septonema stages): on *Quercus palings*, Ann Arbor, Mich., Oct. 17, 1930. All collections by M. L. Lohman.⁵

The hysterothecial stage has been collected only on *Quercus*, by the writer, and the common habitat is exposed medullary rays on radial surfaces of rails and palings. Rail and picket fences, now seldom seen, invariably yield this species. The conidial stage is not uncommon on decorticated limbs of *Quercus*, but the hysterothecial stage has been found only once in such habitat.

Vegetative cultural characteristics. — Vigorously growing mycelium is white and many cultures remain light in color for several weeks. Ordinarily by the third week the superficial layer darkens ("vetiver green") and the narrow margin, the bare surface layer, is "yellowish olive." In older cultures the non-sporiferous mycelium remains light brown ("avellaneous" to "wood" or "clove brown"). When the hyphomycetous stage

⁵ In the writer's material from Ohio and Michigan the general appearance is that of the form called *H. complantatum* Duby (9, p. 38; cf. Ellis and Everhart 460, North Am. Fungi), but the average spore is larger and has more septa. Hysterothecia as large and as prominent as those in Ellis and Everhart 3129, North Am. Fungi, are rare. The asci measure 90–110 (125) $\times$ (15) 18–20 μ and the spores (25) 28–35 (40) $\times$ 8–10 μ . Spores 28 to 35 μ in length are 6–8-septate, and the larger spores are 8–10-septate. It is either the third or fourth cell from the upper end which is swollen, depending upon the number of septa. Ellis (12, p. 696) questionably referred the European *H. Berengerii* Sacc., of similar habitat, to this species.

is abundant, cultures are much darker. The coloration of the oatmeal medium is variable, and this condition appears to be linked with variations in the vegetative expression of different single-spore cultures from the same hysterothecium. The oatmeal medium may be only slightly darkened or it may become a persistent red-brown ("burnt lake" or "madder brown"). The former condition is general for ascus and ascospore cultures which produce pycnidia and for pyrenidiospore cultures, whereas the deep coloration accompanies abundant conidial production and is pronounced in single-conidium cultures regardless of the amount of sporulation. Elliott (10) reported a red-brown chromogenesis of the culture medium for certain species of *Alternaria*, and noted that the strain of *A. solani* from potato produced a discoloration, but the strain from *Datura* did not. Elliott, however, correlated deep chromogenesis with non-sporulating cultures and the lack of coloration with abundant conidial production.

Cultural fructifications. — The Septonema stage first appears as brown erect tufts near the margin. These tufts are composed of sparingly branched tortulose hyphae, arising as vertical branches from similar hyphae in the surface layer. Swollen cells later become septate, deeply constricted at the new and old septa, and finally each of the two cells of a potential conidium becomes cross-septate. Mature conidia (Fig. 38 *F*) of the normal type are 4-celled, deep fuscous, granular-walled, much constricted at the central septum, and measure $15-18 \times 5-6.5 \mu$. They do not separate readily, and chains of six to ten or twelve are not uncommon. Chains of 1- and 2-celled conidia, of muriform conidia, and of sclerotic bodies are also developed (Figs. 38 *I-L*). All types of sporulation germinate readily in distilled water and many of them *in situ* under the moist conditions of bulk-medium cultures. In old cultures, particularly on the Leonian medium, there are clusters of interwoven conidial chains within the surface layer. A single-ascus culture is illustrated (Fig. 31) in which the entire surface is darkened by Septonema conidia.

To determine Septonema conidial development in culture, this imperfect stage was isolated from field material of two sources, one collection being in association with *H. insidens* hysterothecia

and the other free and from another locality. Conidial development in these single-conidium cultures was identical with the sporulation in ascospore and ascus cultures. Single pycnidiospores obtained from a single-ascospore culture were germinated, and six single-spore isolations were made. These cultures ran four months

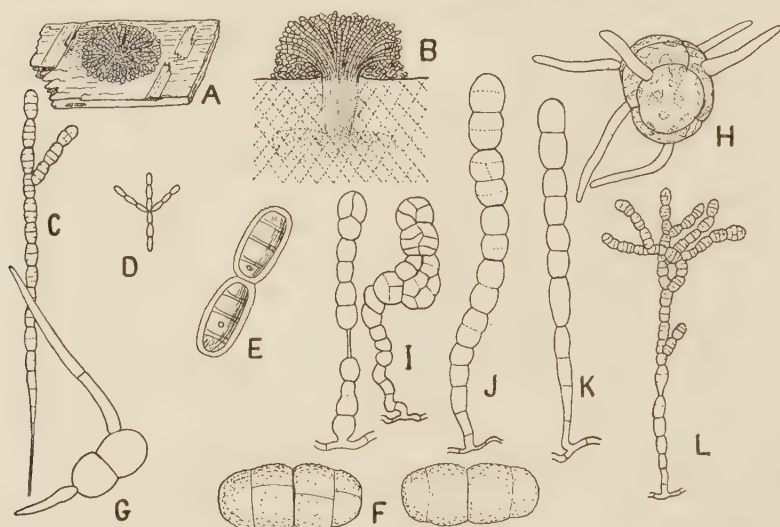


FIG. 38. *Hysterium insidens*; the *Septonema spilomeum* stage. A, conidial fructification on much-weathered *Quercus* rail, $\times 10$; B, vertical section showing point of origin of conidial filaments; C, a typical filament; D-E, the illustrations by Berkeley, after Cooke (*Handbook Brit. Fungi*, 1: 481. 1871); F, typical mature spores from cultures and field material; G, germination of a young conidium obtained in culture; H, germination of a mature conidium from field material; I-L, conidial filaments obtained in cultures

and did not return typical *Septonema* conidia, although the characteristic surface layer of torulose hyphae was developed. The original strain, however, has produced the *Septonema* stage very sparingly.

Pycnidiospores are produced (Figs. 37 E-H) in cavities 90 to 150 μ in diameter. These are largely confined to the surface layer, and the pycnidiospores are discovered only upon microscopic examination of this layer. The surrounding wall is complete,

brown, small-celled parenchymatous, and averages 10 to 15 μ in diameter. The sporulating cells are simple, clustered, and measure $5-8 \times 1-1.5 \mu$. The pycnidiospores are hyaline, elongate-elliptic, inequilateral to suballantoid, acrogenetic, and measure $(2.5) 3-4 \times 1-1.5 \mu$.

Observed associations. -- The *Septonema* stage (Figs. 38 A-C), which usually accompanies in a weathered condition the hysterothecial stage, was identified as *Septonema spilomeum* Berk. (*London Journ. Bot.*, 4:310; t. 12, Fig. 5. 1845), and a study of the type material (No. 92 from Ohio) in the herbarium of Berkeley proved the determination to be correct. In listing this imperfect stage Cooke (4, p. 481) reproduced Berkeley's figures, which are illustrated here (Figs. 38 D-E) for comparison, and correctly quoted Berkeley as follows:

Forming little scattered sori about the size of a poppy seed; threads branched, articulations oblongo-elliptic, triseptate, one or more of the septa occasionally containing an oil globule, border of articulations pellucid, rough with little scabrous prominences. Very distinct in the punctiform habit, and in the nature of the articulations.

The description is true, but in need of revision. Berkeley's figures, which have been reproduced in taxonomic treatments of the hyphomycetous Fungi Imperfecti, do not accurately depict the characters of the material for which they have stood. The distinctive corrections are: (1) the conidia become larger progressively from base to apex of the conidial filament; (2) branching is seldom opposite; (3) conidia are much constricted at the central septum; and (4) a muriform condition is not uncommon in terminal conidia.

Fructifications bearing typical conidia are 0.5 to 2 mm. in diameter, at first greenish yellow, then red-brown and finally black, erumpent and globular by their massed conidial chains, but arising as a palisade of slender hyphae 0.5 to 1 mm. beneath the surface (Figs. 38 A-B). The fructifications are really deep-seated sporodochia. Typical conidia measure $15-21 (24) \times (5) 6-7 \mu$, whereas the larger terminal conidia in old fructifications measure $25-28 (30) \times 6-8 \mu$. Typical 3-septate conidia in the type specimen are smaller, measuring $15-18 \times 7-8 \mu$, but conidial

measurements from other Ohio material in the herbarium of Berkeley agree. In several collections chains of typical conidia, with interconidial strands 4 to 10 μ in length, occur intermingled with normal Septonema chains. The isthmian chains are the basis for the form genus *Polydesmus*. Chains of muriform conidia are also met, and these represent *Sirodesmium*.

The type material of *S. spilomeum* presented two hysterothecia of *H. insidens*, and the Ellis distribution of it (North Am. Fungi 353) in the herbarium of the University of Michigan shows the perfect stage in fine condition. The Ellis distribution of *S. spilomeum* is identical with that of the type material. The *H. complanatum* Duby distributed by Ellis (North Am. Fungi 460) shows numerous *S. spilomeum* fructifications.

The pycnidial stage has been observed in collected material. The pycnidia are membranous-fragile, ostiolate-globular, 50 to 65 μ in diameter and 30 to 40 μ high, with brown, parenchymatous walls 6 to 10 μ in thickness. The hymenial elements agree with those obtained in culture, except that the pycnidiospores are somewhat longer, measuring 4-5 (6) $\times$ 1-1.5 μ .

Hysteroglyphium kansense E. & E. (Pl. XXXV, Fig. 2)

No. 264. On bark of living *Quercus alba* L., Washtenaw County, Mich., Aug. 13, 1930. Collected by A. H. Smith and M. L. Lohman.⁶

This organism was fruiting so abundantly that an area of some fifteen square feet of bark was noticeably darkened.

Vegetative cultural characteristics. — Single-ascus isolations were not obtained for this species. The growing mycelium of single-spore cultures forms a velvety, erumpent mat, greenish slate ("deep slate green" to "iron gray") in color. In their color and composite growth the cultures resemble very much those of

⁶ The material here referred to *H. kansense* E. & E. is identical with Ellis and Everhart 3037, North Am. Fungi, even in that the spores are considerably longer than Ellis (13, p. 22) described them. In the exsiccati the asci measure 130-140 $\times$ 15-18 μ and the spores (25) 30-36 $\times$ 8-10 μ . In the writer's material asci are 130-150 $\times$ 15-20 μ and the spores (29) 34-41 $\times$ 8-10 μ . Seaver (45) says that he examined the type material, and he notes no discrepancies in the measurements made by Ellis and gives identical measurements for his Iowa collections.

Hysterographium vulvatum. The surface layer is loosely stromatic; anastomosing is in the form of a conjunctive union of hyphal tips, and no pseudosclerotial development occurs. Cultures that have run four months have remained sterile.

Observed associations. — Only empty pycnidia accompany the perfect stage. They are superficial, single or aggregated, ostiolate-globular, with thin membranous walls, and measure 100 to 125 μ in diameter.

***Hysterographium minutum* Lohman, sp. nov. (Fig. 39)**

Hysterotheciis 0.5-0.9 (1) mm. longis, 0.15-0.2 (0.25) mm. latis, nigris, supra complanatis cum labiis fere approximatis,

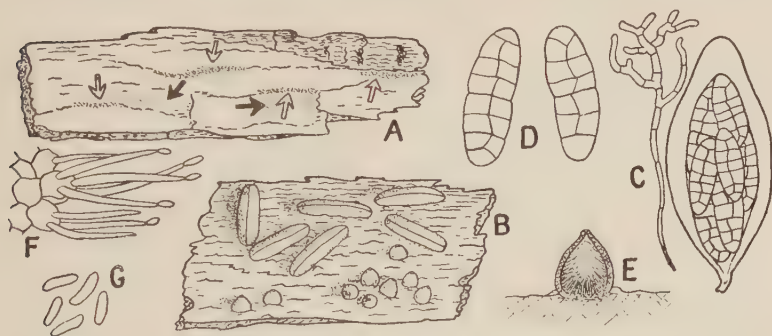


FIG. 39. *Hysterographium minutum*; hysterothecial and pycnidial stages from field material. A, portion of bark, natural size, arrows in outline indicate aggregations of hysterothecia and solid arrows indicate clusters of pycnidia; B, a small portion of same, $\times 20$; C-D, hymenial elements; E-G, characters of the pycnidial stage

prominenter rugosi-punctatis, interdum longitudinaliter striatis, superficialiter erumpentibus, inordinatim in greges separatos, densos, elongatos, 6-10 mm. longos et 2 mm. crassos constipatis, ad rimas corticis exfoliati parallelas, textura carbonaceis, parenchymatosus cum oculis minutis; ascis octosporis, 65-75 $\times$ 20-26 μ , ellipsoideo-globosis aut subpyriformibus, abrupte brevistipitatis; paraphysibus septatis, sursum ramosis et epithecium crassum formantibus; sporidiis (20) 22-27 $\times$ 8-10 μ , inordinate tristichis, oblongo-ellipsoideis, luteolis vel fuscis, 5- vel 7-septatis et muri-formibus, septo medio constrictis.

Copiose in cortice trunci vivi *Aceris saccharini*. *H. pachyasco* affinis, sed hysterotheciis non patelliformibus. Ann Arbor, Mich., Oct. 15, 1929. Specimen typicum in herb. Univ. Mich.

Hysterothecia 0.5–0.9 (1) $\times$ 0.15–0.2 (0.25) mm., flattened above with a narrow fissure, black and shining, prominently rugose-punctate, occasionally with several longitudinal striae above, erumpently superficial and variously oriented in isolated, dense, elongate aggregations 2 mm. in width and seldom exceeding 10 mm. in length, bordering the scars of exfoliation; walls small-celled parenchymatous, thick and carbonaceous; asci 65–75 $\times$ 20–26 μ , 8-spored, subpyriform or elliptic-globose, abruptly short-stipitate, double-walled with the inner wall thick-gelatinous; paraphyses branched and blackened above to form a thick epithecium; spores oblong-elliptic, (20) 22–27 $\times$ 8–10 μ , inordinately triseriate, clear yellowish to reddish brown, constricted at the central septum, becoming 5- to 7-septate, with a longitudinal division through all but the terminal cells.

Abundant on outer bark of trunk, *Acer saccharinum* L., Ann Arbor, Mich., Oct. 15, 1929. Collected by M. L. Lohman (No. 169). Type in the herbarium of the University of Michigan.

The most distinctive characters are the minute hysterothecia and the subpyriform to thick clavate asci of the Arthonia type. The asci of two described species of Hysterographium, namely, *H. pachyascum* Berl. and *H. hiascens* Rehm, approach this type. The latter species, however, although of similar habitat, has larger hysterothecia, much longer asci, and larger spores. Rehm referred material from Ellis to *H. hiascens*, and Ellis (12, p. 707) accepted the species for the coastal states. The writer's material approaches more closely the European *H. pachyascum*, which also has very small hysterothecia, similar spores, and asci which measure 60–70 $\times$ 15–20 μ . It differs from *H. pachyascum* in its habitat and in that the hysterothecia are not at all patelliform.

Vegetative cultural characteristics. — In its cultural features the fungus shows little resemblance to *H. kansense* or to *H. Mori*. It is of rapid growth and vigorous mycelia are scarcely distinguishable from those of *G. simulans*. The dendroid tufts are larger than those in cultures of *G. simulans*, and there is no discoloration

of the medium. The central fascicle of the erect tufts is in many cases 30 to 40 μ in diameter, and is composed of numerous, parallel, anastomosed hyphae. Sporulation has not been observed in culture.

Observed associations. — The ostiolate, obovate pycnidia are superficial, single or aggregated, seated in the outer cell layers of the bark, and measure 125 to 200 μ in diameter. The wall is thin, black, and subcarbonaceous laterally, poorly developed and unblackened below, i.e. of the *Aposphaeria* (?) type; tufted, slender, sporulating cells, measuring $5-8 \times 1 \mu$, line the basal and lateral walls. The pycnidiospores are acrogenetic, hyaline, cylindric-inequilateral, and measure $2-2.5 \times 0.7 \mu$.

Hysterographium Mori (Schw.) Rehm

No. 213. On decorticated limbs of *Rhus typhina* L., Ann Arbor, Mich., May 1, 1930. No. 2. On decorticated trunk of *Ulmus fulva* Michx., Ingham County, Mich., Oct. 14, 1928. No. 6. On decorticated limbs of *Ulmus americana* L., Ann Arbor, Mich., Nov. 15, 1928. No. 32. On decorticated, much-weathered trunk, *Fraxinus* sp., Ann Arbor, Mich., Nov. 15, 1928. No. 7. (originally identified as *H. cinerascens* (Schw.) E. & E.). On decorticated, weathered limbs of *Ulmus americana* L., Ingham County, Mich., Oct. 14, 1928. All collections by M. L. Lohman.

This common species has been collected in abundance in its various forms and intergrading types. The collections show the species to be as variable as Ellis (12, p. 704) has indicated. The writer's decision to relegate *Hysterographium cinerascens* (Schw.) E. & E. to the *H. Mori* group adds to the complexity in that Schweinitz (44, p. 244) described *H. cinerascens* first. Since there is some disagreement concerning the type material of *H. cinerascens* Schw., the writer prefers to employ the name in common use.

Vegetative cultural characteristics. — The strains already mentioned showed no differential characters on the media utilized. All produced a white mycelium, which soon became a persistent gray ("olive-gray") or greenish gray ("tea green"). Mycelia grew at a moderate rate and produced irregularly convoluted

and lobed surface mats 2 to 4 mm. deep, with a very thin superficial layer of delicate hyphae.

Cultural fructifications. — Pycnidiospores are produced in irregular cavities within the surface layer (Fig. 40 B). Centers of pycnidiospore production are noticeable in old cultures as erect

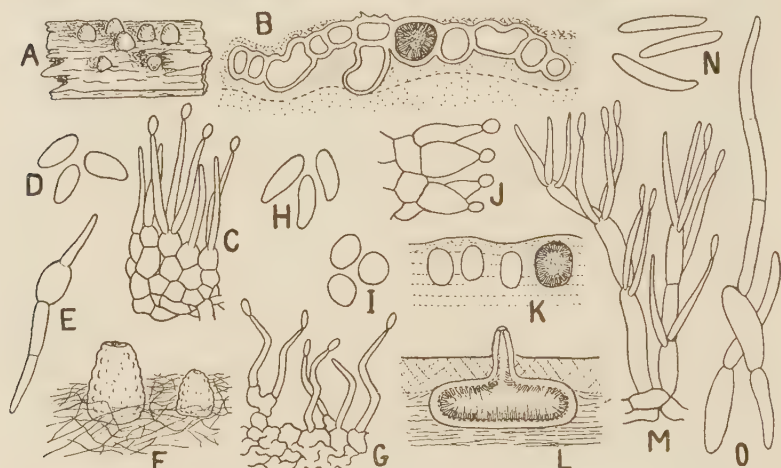


FIG. 40. A-E, *Hysteroglyphium Mori*. A, pycnidia on wood, $\times 20$; B, pycnidial cavities in the surface layer on agar media (the three culture layers are indicated); C-D, sporulating cells and pycnidiospores; E, germinating pycnidiospores; C-E, for field material and cultures. F-H, *Hysteroglyphium vulvatum*; pycnidial stage obtained in culture. F, pycnidia, $\times 75$; G-H, spore-bearing cells and pycnidiospores. I-K, *Hysteroglyphium formosum*; pycnidial stage obtained in culture. I-J, pycnidiospores and spore-bearing cells; K, cavities in surface layer on agar medium. L-O, *Hysteroglyphium Fraxini*; pycnidial stage from cultures on sterilized ash twigs. L, section view of pycnidium within the bark, $\times 40$; M-N, spore-bearing cells and pycnidiospores; O, germinating pycnidiospores

tufts of white delicate hyphae produced by subsequent upward growth of the hyphae, which differentiate the walls of the cavities, and by the germination of exuded pycnidiospores under moist culture conditions. The wall is brown, small-celled parenchymatous, and measures 10 to 15 μ in thickness. The simple sporulating cells are 8-10 $\times$ 1.5-2 μ and abstrict the hyaline pycnidiospores singly from their tips. These spores are elliptic-inequilateral to ovate and measure (2) 2.5-3.5 (4) $\times$ (0.7) 1-2 μ .

Observed associations. — A pycnidial stage (Figs. 40 A, C-E) of the *Aposphaeria* type is commonly associated with all the forms given above. The pycnidia are erumpently superficial, 100 to 125 μ in diameter, and usually precede and border the aggregations of hysterothecia. The hymenial elements are identical with those obtained in culture. The pycnidia arise within the wood or as cavities in the thin, black crust, with their basal walls poorly developed at first. But the blackened, subcarbonaceous wall is complete in mature pycnidia. This stage is usually more abundant in material referable to *H. cinerascens*, since the numerous minute pycnidia are largely responsible for the ashy coloration of the wood.

Hysteropycnis admixta and *H. confluens* (see pp. 232-233), recently described by Hilitzer (18, p. 152) as associated with *Hysterographium Dubyi* Hilitzer and *H. elongatum* Corda, respectively, are probably pycnidial stages very similar to that associated with *H. Mori*.

Hysterographium Lesquereuxii (Duby) Sacc.

No. 11. On decorticated limbs of *Acer saccharinum* L., Ann Arbor, Mich., Oct. 20, 1928. Collected by M. L. Lohman. This material is tentatively referred to *H. Lesquereuxii*.

The cultures of this fungus showed constant slight differences from cultures of all forms of *H. Mori*. As compared with the latter cultures, the mycelia remain lighter in color with a tinge of yellow, the oatmeal is discolored yellow and then olive-brown at room temperature, the superficial weft is deeper, broadly zoned, and crenately lobed on the margin, and pycnidiospores are produced in greater abundance. The pycnidial stage, in culture and on collected material, is indistinguishable from that of *H. Mori*.

In spite of the differences in cultural characteristics and spore markings the material tentatively referred to *H. Lesquereuxii* (Duby) Sacc. is probably only another form of *H. Mori*.

Hysterographium formosum (Cooke) Sacc.

No. 245. On fallen twigs of *Pinus albicaulis* Englem., Crater Lake National Park, Ore., Sept. 10, 1929. Collected by L. N. Goodding.

Hysterothecia as described by Ellis (12, p. 702); asci 100–130 $\times$ 10–12 μ ; spores 18–21 $\times$ 7–8 μ . The material agrees with the type “1020. *Hysterium formosum* Cooke,” at Kew.

This western species will probably be found to be identical with the European *H. Pumilionis* Rehm (36, p. 21), which, according to Rehm (38, p. 109), is common on dead twigs of *Pinus* in alpine regions.

The spores of *H. formosum* germinate at 20 to 25° C., but the organism demands low temperatures for vigorous vegetative growth. When subcultures on the Leonian medium from vigorous mycelia at 10° C. were placed at room temperature, there was a transformation of the mycelium into a compact sclerotial mass, but new hyphae scarcely penetrated the medium. Such transfers showed no appreciable growth in eight weeks, whereas cultures of the same duration at 10° C. developed a mycelial web 2 cm. in diameter. At eight weeks a set of the former cultures was removed to 10° C. and vigorous mycelial development followed.

Vegetative cultural characteristics. — Growing mycelium (in this case on sucrose oatmeal at 10° C.) is black and forms a smooth surface layer suggesting *Hysterium pulicare*, but a gray-green superficial layer develops tardily. At 20 to 25° C. the sclerotic bodies are dark brown, owing to the production of numerous, intercalary or terminal, globose resting cells, which are occasionally septate.

Cultural fructifications. — Pycnidiospores are produced in abundance at 10° C. on the oatmeal medium. The rather regular, spherical cavities (Fig. 40 I), 150–250 μ in diameter, are developed in clusters within the surface layer. The spores escape and form on the surface irregular, firm, white mucilaginous concretions. The pycnidiospores are subglobose to short-oblong, 2 μ in diameter or 2.5 $\times$ 2 μ , and they are abstricted from inverse-pyriform sporulating cells 4 to 6 μ in length (Fig. 40 J–K). It is to be noted that these spores and spore-bearing cells are of the type described for *Mytilidion tortile*.

Hysterographium vulvatum (Schw.) Rehm. (Pl. XXXV, Fig. 1)

No. 4. On decorticated twigs of *Quercus alba* L., Ann Arbor, Mich., Nov. 13, 1928. Collected by M. L. Lohman.

The variability in hysterothecial development and spore size encountered in this large-spored *Hysterographium*, common about Ann Arbor on the bark and decorticated areas of dead twigs of *Quercus*, suggests that the names *Hysterium flexuosum* Schw. (43, p. 49) and *H. vulvatum* Schw. (44, p. 243) probably apply to the same organism. In Ann Arbor collections the spores measure (45) 50–58 (65) $\times$ (12) 14–18 (22) μ .

In its vegetative cultural characteristics *H. vulvatum* resembles *H. kansense*, except that the superficial layer is a darker green.

Cultural fructifications. — Pycnidiospores appear in large quantities on the oatmeal medium. Hymenial tissue is developed upon the surface layer without cavity formation, and the masses of spores are soon covered by superficial, delicate hyphae. The pycnidiospores are hyaline, acrogenetic, oblong-inequilateral, and measure $3\text{--}4 \times 1.3\text{--}1.5 \mu$. The sporulating cells measure $5\text{--}8 \times 1.5 \mu$. They are variously bent and arise singly from a loose tissue of delicate, much-branched hyphae (Figs. 40 *G*–*H*). Ostiolate pycnidia (Fig. 40 *F*) 75 to 90 μ in diameter and 100 to 150 μ in height were produced in the aërial mycelium of certain granulated cork cultures. These pycnidia had membranous walls 6 to 8 μ thick, including the loose subhymenium, and hymenial elements as described for the cultures on oatmeal. The surface layer on the oatmeal medium contains numerous, one- or several-celled, brown chlamydospores.

Hysterographium Fraxini (Pers. ex Fr.) De Not.

No. 300. On bark, fallen twigs of *Fraxinus pennsylvanica* Marsh., Manitoba Agricultural College Grounds, Winnipeg, Canada, Sept. 17, 1930. Collected by Professor G. R. Bisby.

H. Fraxini was collected at Ann Arbor in 1895, but it has not been reported since that date. It is one of the classic species of the group.

Vegetative cultural characteristics. — The spores germinate by a number of abruptly branched, septate, coiled and interwoven hyphae (31). Mycelial growth is white, as Brefeld (3, p. 271) noted, and where a superficial layer is developed, as on the oatmeal medium, it remains white until the third or fourth month.

On the cork-decoction medium the superficial layer is lacking, and the culture is dark brown. A scant, superficial, white mycelium is produced on sterilized ash twigs. On agar media the hyphae secrete a mucilaginous substance in great amounts, giving elastic properties to the tough mycelial wefts.

Cultural fructifications. — Drops from one capsule of sterile distilled water containing spores in suspension were placed upon nutrient agar plates and upon steam-sterilized ash twigs. From the nutrient plates a number of single-spore and single-ascus isolations were made. When growth from these isolations permitted, transfers were made to steam-sterilized ash twigs, to cork-decoction media, and to fresh bark wounds on dormant ash twigs in the laboratory. By the fourth week the sterilized twigs that had been inoculated with a mass of germinating ascospores showed scattered olive-green spore horns. Observation at the end of the fourth month revealed that pycnidia had not been formed in any single-spore and single-ascus culture on the agar media, nor on dormant or steam-sterilized ash twigs that had been inoculated from such cultures. Uninoculated steam-sterilized twigs remained sterile.

The pycnidia (Fig. 40 *L-O*) which were responsible for the spore horns noted above are intracorticular, 500 to 600 μ in diameter and 200 to 270 μ in height, exclusive of the protruding ostiolate papillae, and they have complete, small-celled, clear-brown, parenchymatous walls averaging 25 μ in thickness. The pycnidiospores are hyaline, cylindric-bent to allantoid, and measure $4.5-5 \times 0.8-1.2$ μ . The spore-bearing cells measure $8-12 \times 1-2$ μ , but they arise in irregular clusters from a thicker, septate, central hypha. If the latter is considered the conidiophore, the pycnidial stage is referable to *Dendrophoma* Sacc. in the systems of Von Höhnelt (20) and Diedicke (8), or possibly to *Ceratophoma* in the system of Von Höhnelt.

A pycnidial stage with more superficial fructifications, but with similar spores, has been described for this species as *Hysteropycnis Fraxini* Hilitzer (18, p. 152).

A stylosporoc stage (see p. 232), as described by Rostrup (40) and referred by Lind (26) to the form genus *Myxosporium*, has

not been observed by the writer, in cultures or in collected material.

Observed associations. — The source material shows an intracorticular pycnidial stage, but the pycnidia are considerably smaller than those obtained in culture, and they are without hymenial elements.

Gloniopsis brevisaccata Lohman, sp. nov. (Pl. XXXIV, Fig. 3)

Hysterotheciis 0.6–0.8 (1) mm. longis, 0.15–0.25 mm. latis, atris, rugosi-punctatis, lineari-oblongis, superficialiter erumpentibus sed sursum complanatis, rimis longitudinalibus et striis parallelis obscuris, dense longiseriatis secus ligni interstitia, textura carbonaceis, parenchymatosis cum loculis minutis; ascis breviter clavatis, octosporis, 65–75 μ longis, 15–21 μ crassis; paraphysibus filiformibus, sparsis, septatis, supra ramosis et intertextis, epithecium fuliginereum formantibus; sporidiis hyalinis, indistincte merenchymatosis, subtristichis vel inordinate distichis, 28–30 (35) $\times$ (10) 12–14 μ , leviter curvatis, 7- vel 10-septatis, septo medio quam ceteris validius constricto, utroque obtusis.

Habitat superne in trunco erecto vetusto querceo. Ann Arbor, Mich., Nov. 15, 1928. Specimen typicum in herb. Univ. Mich.

Hysterothecia 0.6–0.8 (1) $\times$ 0.15–0.25 mm., linear-oblong, flattened, rugose-punctate, erumpently superficial, densely gregarious, in long linear series following the interstices of the wood, each with a few faint striae paralleling the shallow longitudinal fissure; walls carbonaceous, rather thin but small-celled parenchymatous; asci short-clavate, double-walled, 65–75 $\times$ 15–21 μ ; paraphyses sparse, slender, septate, branched and interwoven above to form a brownish epithecium; spores hyaline, curved with obtuse ends, subtriseriate to biseriate, 28–30 (35) $\times$ (10) 12–14 μ , 7 to 10 cross-septate, deeply constricted at the central septum and less so at the primary septum of each half, indistinctly merenchymatous by a number of longitudinal divisions.

Near top of standing fence post (*Quercus*); Ann Arbor, Mich., Nov. 15, 1928. Collected by M. L. Lohman (No. 25). Type in the herbarium of the University of Michigan.

The fungus was again collected from the same post on September 18, 1930. The minute hysterothecia and the large spores in

short, thick asci are the distinctive characteristics. In respect to the latter the fungus approaches *G. decipiens* De Not. (6, p. 23; cf. Rehm 36, p. 18). The material was tentatively referred to *Hysterium lineolatum* as described by Cooke (Grev., 11:107. 1883) — not *Hysterographium praelongum* (Schw.) E. & E., Ellis 1321 (North Am. Fungi) — but an examination of the type material from Cooke's herbarium indicated that the writer's material cannot be referred to Cooke's species, which, perhaps, should be transferred to the genus *Tryblidaria*. Incidentally, the type materials indicate clearly how Ellis (12, p. 708) came to err in regarding the names *Hysterium lineolatum* Cooke and *H. praelongum* Schw. as synonyms.

Vegetative cultural characteristics. — The organism is distinguished from *Glonium simulans* by the persistently lighter color of the aërial mycelium and a fainter discoloration of the oatmeal medium. In old cultures it produces the erect dendroidal tufts noted for *Hysterographium minutum*. These tufts presented aërial pycnidial primordia, but sporulation was not observed.

Gloniopsis Gerardiana Sacc.

No. 5. On decorticated limb of *Ulmus americana* L., Ann Arbor, Mich., Nov. 15, 1928. Collected by M. L. Lohman.⁷

Cultures of this species differ from those of *H. Mori* in that they are lighter in color, the superficial layer is thinner and more compact, and primarily in that concentric zonations and symmetrical radial folding are constant characteristics.

Cultural fructifications. — Pycnidiospores were produced in abundance, and this stage could not be distinguished from that obtained culturally for *H. Mori*.

Observed associations. — Pycnidial accompaniment is more frequent in collections of this species than in those of *H. Mori*. Pycnidia (Fig. 40 A) of the two species are not satisfactorily distinguished by morphological characteristics.

⁷ This is *Hysterographium gloniopsis* (Ger.) E. & E. as described by Ellis (12, p. 708). The validity of his synonymy has not been verified. In the original material for cultures the asci measure $55-60 \times 10 \mu$ and the spores $15 \times 5-6 \mu$. In other details the spores agree with those described by Ellis (*op. cit.*) and by Gerard (17, p. 78).

Hysteropatella Prostii (Duby) Rehm

No. 144. On bark and wood of fallen twigs, *Fraxinus pennsylvanica* Marsh., Randolph County, Ind., Sept. 17, 1929. Collected by M. L. Lohman.

Rehm (36, pp. 301, 367; 38, p. 104) studied this species more fully than any other student of the group. Ellis (12, p. 697) and Seaver (45, p. 112) have described American material.

Vegetative cultural characteristics. — Developing mycelia are black and form a smooth surface layer. Cultures are distinguished from those of *Hysterium pulicare* by the pycnidial stage, which is more erumpent and of earlier appearance.

Cultural fructifications. — Pycnidial primordia arise singly or clustered within the surface layer. Clustered primordia develop a compound fructification. Mature fructifications (Fig. 41 A) are slightly erumpent from the surface layer and measure 75 to 100 μ in diameter and 100 to 200 μ in height. The wall is thin, complete, and small-celled parenchymatous. The spore-bearing cavities may coalesce through the dissolution of intervening tissue, or the coalescence may occur only apically, which results in a labyrinthiform central portion. Fructifications of the latter type have a broad opening above which is surrounded by a thick palisade of delicate hyphae. The hymenium consists of irregularly clustered sporulating cells measuring $8-12 \times 1.5-2 \mu$, and of thicker, septate, long-tapering sterile hyphae. The pycnidiospores (Figs. 41 B-C) are acrogenetic, hyaline, elongate, slightly curved, and measure $3-4.5 \times 1-1.5$ (2) μ . These spores were germinated, and the development of septate, branching hyphae from individual spores was observed (Fig. 41 D).

Hysteropatella clavispora (Peck) Seaver

No. 143. On inner bark at storm break, *Salix* sp., Randolph County, Ind., Sept. 17, 1929. Collected by M. L. Lohman.⁸

⁸ When Seaver (45, p. 113) transferred *Tryblidium clavaesporum* Peck (33, p. 143) to the genus *Hysteropatella*, he listed *Patellaria clavispora* (Peck) Sacc. (*Syll. Fung.*, 8:787) as a synonym of the new combination, but he failed to include *Tryblidiella clavispora* (Peck) Berl. & Vogl. (*Syll. Fung.*

Vegetative cultural characteristics. — Mycelial growth is confined to the medium. This results in a smooth surface layer, as noted under *H. Prostii*. Cultures of this species, however, are sordid white to yellowish brown and become black only on standing for several months. The blackening appears as pycnidial production begins. Cultures producing pycnidia in abundance

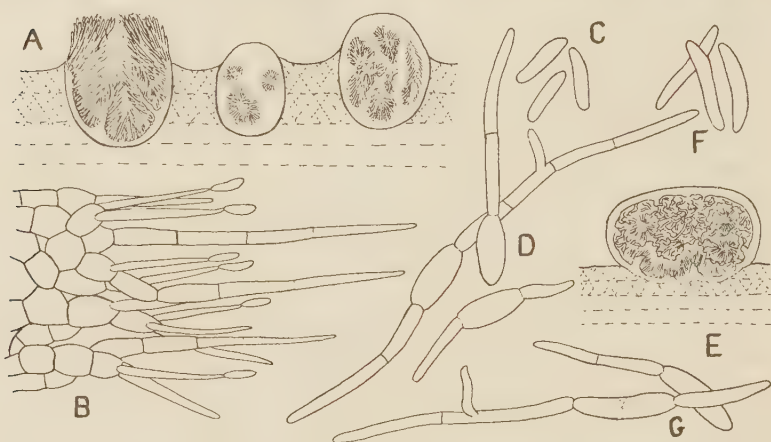


FIG. 41. A-D, *Hysteropatella Prostii*; pycnidial stage from cultures. A, sectional view of fructifications in surface layer on agar medium, $\times 150$; B-C, spore-bearing cells and pycnidiospores; D, germinating pycnidiospores. E-G, *Hysteropatella clavispora*; pycnidial stage from cultures. E, immature fructification on agar medium, $\times 50$; F, pycnidiospores; G, the same, germinating

are entirely black and are distinguishable from those of the preceding species and those of *Hysterium pulicare* by the more numerous exuded masses of pycnidiospores.

Cultural fructifications. — The pycnidial stage (Figs. 41 E-G) obtained in culture corresponds in its general type to that described for the preceding species. Compound fructifications are larger, measuring 300 to 400 μ in diameter and 150 to 200 μ in height. The pycnidiospores of this species are more elongated,

Addit. 1-4, p. 267), which also becomes a synonym. Rehm (37) did not include this species in his revision of Tryblidium and Tryblidiella. The description given by Ellis (12, p. 690) is adequate for my material.

measuring 4-5 (6.5) $\times$ 0.9-1.5 (2) μ , and they are definitely allantoid to subsigmoid. They are exuded in greenish yellow masses rather than in the sordid white globules of the preceding species. They show under magnification a more dense, protoplasmic content, which occasionally appears two-parted at the time of germination. Mycelial development from germinating pycnidiospores was also observed in this species.

GENERAL CONCLUSIONS

1. The results of the studies indicate that apparently only a few of the species of the carbonaceous, hysteriaceous fungi have hyphomycetous imperfect stages.

Since these studies establish a Papulospora stage for *Lophium mytilinum* (Pers.) Fr. and a Septonema stage for *Hysterium insidens* Schw., supposedly an American species, similar stages might be sought respectively in connection with the European forms of the former species and with the European *H. Berengerii* Sacc., which is similar to *H. insidens* in its habit and morphology.

2. The pycnidial ("spermatogonial") fructifications, with their minute pycnidiospores ("spermatia"), do show specific differences, as evidenced by the three types of secondary spores (Table II).

This situation contradicts Duby's (9, p. 27) conception of the worthiness of such studies in this group and supports Rehm's (36, p. 3) anticipations that a study of the imperfect stages might possibly make clearer the position and limitation of species in this group. Among the nineteen species for which a pycnidial stage is described in this report only *Hysterographium Mori* (Schw.) Rehm, *H. Lesquereuxii* (Duby) Sacc., and *Gloniopsis Gerardiana* Sacc. present both in culture and in field material pycnidial stages which cannot be satisfactorily distinguished.

3. Secondary spore stages are expressions of particular potentialities of the fungus, and the form of their reproductive cells is constant, within limits. They cannot be ignored, therefore, if our conception of specific relationships is to be founded upon the full biology of the organism concerned.

The similarity of the pycnidial stages of *Glonium parvulum*

TABLE II
SYNOPSIS OF LIFE-HISTORIES PRESENTED *

Species	Imperfect stages	Pycnidiospores	
		Type	Germination
LOPHIUM			
L. mytilinum	Papulospora mytilina (c, a) and pycnidial near Dothiorella (c, a)	II	c, a
GLONIUM			
G. stellatum	Sphaeronaema byssoideum (a)	II	
G. parvulum	Sphaeronaema parvulum (c, a)	II	c
G. lineare	Plenodomus-Dothiopsis-Phomopsis group (c, a)	II	
MYTILIDIUM			
M. tortile	Pycnidial (c), undetermined	I	
M. decipiens	Hyphomycetous (c), undetermined . .		
	Pyrenochaeta-Sclerochaeta ? (c) . . .	I	
M. resinicola	Aposphaeria ? (a)	I	a
M. Thujarum	Pycnidial near Aposphaeria (a)	I ?	
HYSTERIUM			
H. pulicare	Pycnidial (c, a), undetermined	III	c, a
H. insidens	Septonema spilomeum Berk. (c, a) Pycnidial (c, a), undetermined	III	c
HYSTEROGRAPHIUM			
H. minutum	Aposphaeria ? (a)	III	
H. Mori	Aposphaeria (c, a)	II	c, a
H. Lesquereuxii	Aposphaeria (c, a)	II	
H. formosum	Pycnidial (c), undetermined	I	
H. vulvatum	Pycnidial (c)	III	
H. Fraxini	Dendrophoma-Chaetophoma (c) . . .	III	c
GLONIOPSIS			
G. Gerardiana	Aposphaeria (c, a)	II	c
HYSTEROPATELLA			
H. Prostii	Pycnidial (c), undetermined	III	c
H. clavispora	Pycnidial (c), undetermined	III	c

* Imperfect stages were not discovered for the following species: *Lophium dolabriforme*, *Glonium simulans*, *Mytilidium laeviusculum*, *Hysterium angustatum*, *Hysterographium kansense*, and *Gloniopsis brevisaccata*.

For explanation of letters and roman numbers see bottom of opposite page.

(Ger.) Cooke and *G. stellatum* Muhl. suggests a reasonable intra-generic relationship and is not favorable to the adoption of *Psiloglonium* v. H. with generic ranking on the basis upon which it was founded by Von Höhnelt (19) and emended by Petrak (34). Also, when species have been described (*Hysterium cinerascens* Schw., *H. Mori* Schw., *H. Rousselii* De Not., and *H. Gerardi* C. & P.) and later found to lack diagnostic characters of value and to possess identical secondary spore stages, a broadening of the species concept is most feasible.

4. An appreciation of the real significance of our knowledge of the life-histories of these species, in relation to their generic positions, must await the determination of imperfect stages in a sufficiently large number of the species.

5. For the purpose of comparison the size and form of the pycnidiospores and the cells from which they originate are more reliable than characters pertaining to the tissue which supports them, whether the cultural fructification or field material is being considered.

6. Vegetative cultural characters alone are distinctive and might possibly aid in the classification of species which show intermediate generic characters in the morphology of the hysterothecium.

In the past *Mytilidion* has been distinguished from *Hysterium* primarily by the form of the hysterothecium. The thickness and hyphal structure of the wall, criteria which have not been emphasized by previous workers, are of greater importance. *Mytilidion Thujarum* (C. & P.) Lohman is intermediate between *Hysterium*

EXPLANATION OF LETTERS AND ROMAN NUMBERS USED
IN TABLE II

- c — obtained in culture
 - a — associated with perfect stage in field material
 - I — pycnidiospores spherical to subglobose; spore-bearing cells usually minute, obovate, and difficult to discern
 - II — pycnidiospores ovate-inequilateral to oblong-elliptic; spore-bearing cells usually slender-clavate
 - III — pycnidiospores elongate-cylindric and suballantoid or subsigmoid; spore-bearing cells slender-clavate and usually longer than in group II
- The form of the pycnidium and the development and the texture of the wall vary in each of the three groups.

and Mytilidion in that the hysterothecia are not truly conchiform, but do possess thin walls of a prosenchymatous structure characteristic of conchiform hysterothecia. In its cultural characters the fungus resembles certain species of Mytilidion.

7. In determining the affinities of the family the value of a knowledge of secondary spore stages will be manifoldly increased when a similar knowledge has been made available for the Lophiostomataceae and for certain genera of the Patellariaceae, the Tryblidiaceae, and the Graphidaceae.

Life-history studies in these various forms and in the Hypodermataceae will probably yield evidence in support of Von Höhnelt's (19) disposition of the species of the old order, just as the cultural studies by Wehmeyer (46) on certain species of the stromatic Sphaeriales supported, in general, Von Höhnelt's revisions of that group.

SUMMARY

A physiological study involving single-spore and single-ascus cultures of carbonaceous, hysteriaceous fungi, intended to derive some information that might supplement the morphological characters in the taxonomy of the species, has resulted in the isolation and comparative cultural study of twenty-two known species and three apparently heretofore undescribed forms. *Gloniopsis brevisaccata*, *Hysterographium minutum*, and *Mytilidion resinicola* are described in this paper as new species.

The cultural studies have indicated that in general the species are distinct in their vegetative characteristics and that fifteen of the twenty-five species produce secondary spore stages in culture. In three of the species that remained sterile in culture a pycnidial stage was observed as associated with the perfect stage in field material and accepted in each case as belonging to the known perfect stage because imperfect stages of similar type had been obtained in cultures of closely related species.

Three species possess hyphomycetous stages: *Lophium mytilinum* (Pers.) Fr., with a Papulospora type for which the name *P. mytilina* is suggested; *Mytilidion decipiens* (Karst.) Sacc., with an unidentified mucedinaceous stage; and *Hysterium insidens* Schw., with a Septonema stage determined as *S. pilomeum* Berk.

Lophium dolabriforme Wallr. develops catenulate filaments in culture, but they are not definitely interpreted as a form of conidial reproduction.

For nineteen of the species some information has been obtained concerning the pycnidial stages. These stages are described in detail and most of them are figured. All show hyaline, one-celled pycnidiospores. Three types of pycnidiospores are recognized: (1) spherical to subglobose and typically produced on minute, obovate, spore-bearing cells; (2) ovate-inequilateral to oblong-elliptic and typically produced on slender, clavate, spore-bearing cells; and (3) elongate or cylindric, straight, suballantoid to subsigmoid, and produced on elongate-clavate, spore-bearing cells, many of which are accompanied by sterile filaments. *Mytilidion tortile* (Schw.) Sacc., *M. decipiens* (Karst.) Sacc., *Mytilidion resinicola* Lohman, sp. nov., *M. Thujarum* (C. & P.) Lohman, comb. nov., and *Hysterographium formosum* (Cooke) Sacc. show pycnidial stages of the first type. *Lophium mytilinum* (Pers.) Fr., *Glonium stellatum* Muhl., *G. parvulum* (Ger.) Cooke, *G. lineare* (Fr.) De Not., all the forms of *Hysterographium Mori* (Schw.) Rehm, *H. Lesquereuxii* (Duby) Sacc., and *Gloniopsis Gerardiana* Sacc. give pycnidial stages of the second type. *Hysterium pulicare* Pers. ex Fr., *H. insidens* Schw., *Hysterographium vulvatum* (Schw.) Rehm, *H. Fraxini* (Fr.) De Not., *Hysterographium minutum* Lohman, sp. nov., *Hysteropatella Prostii* (Duby) Rehm and *H. clavispora* (Peck) Seaver compose the third group.

The pycnidial stages of *G. parvulum* and *G. stellatum* are referred to the form genus *Sphaeronaema*, as *S. parvulum* Lohman, status novus, and *S. byssoideum* Lohman, status novus, respectively. The pycnidial stages of *Hysterographium Mori*, *H. Lesquereuxii*, and *Gloniopsis Gerardiana* are of the form genus *Aposphaeria*. They are not satisfactorily distinguished. The pycnidial stage of *M. resinicola* might be referred to the same form genus, but its pycnidiospores are subglobose.

Although these spores average less than $2\ \mu$ in diameter and the elongate forms seldom exceed $6\ \mu$ in length, they are referred to as pycnidiospores and their fructifications as pycnidia because the spores have been germinated and hyphal development has

been observed in the following species: *Glonium parvulum*, *Lophium mytilinum*, *Mytilidion resinicola*, *Hysterium pulicare*, *H. insidens*, *Hysterographium Fraxini*, *H. Mori*, *Gloniopsis Gerardiana*, *Hysteropatella Prostii*, and *H. clavispora*. Single germinating pycnidiospores of *L. mytilinum*, *G. parvulum*, and *H. insidens* were isolated, and the pycnidiospores produced mycelia similar to those of ascospore cultures in the respective species, and in each species returned the pycnidial stage in culture.

As a result of the observations on field material and in view of comparative cultural data, the following revisions in the taxonomy of the family are made: *Hysterium Thujarum* C. & P. is transferred to the genus *Mytilidion*; *Hysterographium cinerascens* (Schw.) E. & E. is considered only a form of *H. Mori* (Schw.) Rehm. Also, there is evidence that the genus *Psiloglonium* Petrak is apparently not well founded.

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EXPLANATION OF PLATES XXXIV-XXXV

(All materials are illustrated twice the natural size.)

PLATE XXXIV

- FIG. 1. *Mytilidion tortile* (Schw.) Sacc., on bark of living *Juniperus virginiana* L.; the minute, scattered, subflexuous, acutely ridged and irregularly oriented fructifications are distinctive.
- FIG. 2. *Mytilidion Thujarum* (C. & P.) Lohman, comb. nov. (*Hysterium Thujarum* C. & P., *Bull. Buffalo Soc. Nat. Sci.*, p. 33. 1875), on bark of old stumps, *Thuja occidentalis* L.
- FIG. 3. *Gloniopsis brevisaccata* Lohman, sp. nov., on much-weathered, standing post (*Quercus*).
- FIG. 4. *Glonium simulans* Ger., on decorticated wood of *Tilia americana* L.; note the blackened condition of the wood and the obtuse ends of the hysterothecia.
- FIG. 5. *Glonium stellatum* Muhl. (*Sphaeronaema byssoideum* Lohman, status novus *Glonii stellati*), on much-decayed *Quercus* log; note the minute, scattered, beaked pycnidia.

PLATE XXXV

- FIG. 1. *Hysterographium vulvatum* (Schw.) Rehm, on a weathered, fallen branch of *Quercus alba* L.; the several longitudinal striations which parallel the central fissure are unusually prominent in the material of this collection.
- FIG. 2. *Hysterographium kansense* E. & E., on bark of living *Quercus alba* L.; easily mistaken for *Hysterium pulicare* Pers. ex Fr. until examined microscopically; the hysterothecia are slightly more robust than those of *H. pulicare*.
- FIG. 3. *Hysterium insidens* Schw. (*Septonema spilomeum* Berk., *London Journ. Bot.*, 4: 310. 1845), on much-weathered paling (*Quercus*) of old and dilapidated picket fence; note (central portion and upper right) the circular, erumpent, weathered fructifications of the *Septonema* imperfect stage.

PLATE XXXIV

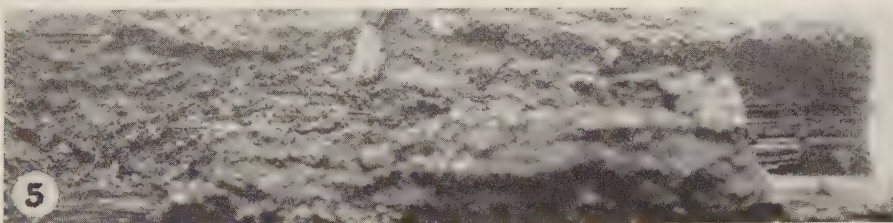
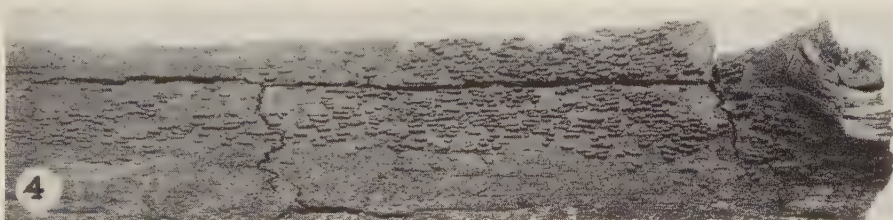


PLATE XXXV

